

FISHERY DATA SERIES NO. 92

STOCK ASSESSMENT OF ARCTIC GRAYLING IN THE  
TANGLE LAKES AND RIVER SYSTEM, 1986 - 1988<sup>1</sup>

By

Timothy T. Baker

Alaska Department of Fish and Game  
Division of Sport Fish  
Juneau, Alaska 99802

July 1989

<sup>1</sup> This investigation was partially financed by the Federal Aid in Sport Fish Restoration Act (16 U.S.C. 777-777K) under Project F-10-4, Job No. G-8-6.

The Alaska Department of Fish and Game operates all of its public programs and activities free from discrimination on the basis of race, religion, color, national origin, age, sex, or handicap. Because the department receives federal funding, any person who believes he or she has been discriminated against should write to:

O.E.O.  
U.S. Department of the Interior  
Washington, D.C. 20240

# TABLE OF CONTENTS

	<u>Page</u>
LIST OF TABLES.....	iii
LIST OF FIGURES.....	vi
ABSTRACT.....	1
INTRODUCTION.....	2
STUDY SITE.....	4
METHODS.....	4
1986 Field Study.....	4
1987 Field Study.....	5
1988 Field Study.....	5
June Sampling.....	5
July Sampling.....	6
August Sampling.....	6
September Sampling.....	6
Data Collection.....	6
Estimation of Mixing Rates.....	7
Estimation of Relative Stock Density (RSD).....	7
Estimation of Age Composition.....	8
Estimation of Mean Fork Length-at-Age.....	8
RESULTS AND DISCUSSION.....	9
1986 Results.....	9
Length Frequencies.....	9
Relative Stock Density.....	9
Age Composition.....	16
Mean Fork Length-at-Age.....	16

# TABLE OF CONTENTS (Continued)

	<u>Page</u>
1987 Results.....	16
Length Frequencies.....	16
Relative Stock Density.....	16
Age Composition.....	25
Mean Fork Length-at-Age.....	25
1988 Results.....	25
Estimation of Mixing Rates.....	25
Length Frequencies.....	25
Relative Stock Density.....	37
Age Composition.....	37
Mean Fork Length-at-Age.....	37
ACKNOWLEDGEMENTS.....	51
LITERATURE CITED.....	51

# LIST OF TABLES

<u>Table</u>	<u>Page</u>
1. Summary of Arctic grayling caught, marked, and recaptured in the Tangle Lakes and River system, Alaska, July through September 1986.....	10
2. Estimates of Relative Stock Density (RSD) by gear type for Arctic grayling in the Tangle Lakes and River system, Alaska, July through September 1986.....	15
3. Estimates of Relative Stock Density (RSD) by area for Arctic grayling in the Tangle Lakes and River system, Alaska, July through September 1986.....	17
4. Estimates of the contributions of each age class of Arctic grayling, for each gear type used in the Tangle Lakes and River system, Alaska, July through August 1986.....	18
5. Estimates of the contributions of each age class of Arctic grayling for each location sampled in the Tangle Lakes and River system, Alaska, July through August 1986.....	19
6. Estimates of mean fork length-at-age (mm) of Arctic grayling in the Tangle Lakes and River system, Alaska, July through September 1986.....	20
7. Summary of the number of Arctic grayling caught, marked, and recaptured in the Tangle Lakes and River system, Alaska, during 1987.....	21
8. Estimates of Relative Stock Density (RSD) for Arctic grayling in the Tangle Lakes and River system, Alaska, June through August 1987.....	24
9. Estimates of the contributions of each age class of Arctic grayling in the Tangle Lakes and River system, Alaska, June through August 1987.....	26
10. Estimates of the mean fork length-at-age (mm) of Arctic grayling in the Tangle Lakes and River system, Alaska, June through August 1987.....	27
11. Location summary of the number of Arctic grayling caught, marked, and recaptured in the Tangle Lakes and River system, Alaska, during 1988.....	28

# LIST OF TABLES (Continued)

<u>Table</u>	<u>Page</u>
12. Date and gear summary of the number of Arctic grayling caught, marked, and recaptured in the Tangle Lakes and River system, Alaska, during 1988.....	29
13. Estimates of Relative Stock Density (RSD) by date for Arctic grayling in the Tangle Lakes and River system, Alaska, 1988.....	39
14. Estimates of Relative Stock Density (RSD) by location for Arctic grayling in the Delta River and lower sections of the Tangle Lakes and River system, Alaska, 1988.....	40
15. Estimates of Relative Stock Density (RSD) by location for Arctic grayling in the middle sections of the Tangle Lakes and River system, Alaska, 1988.....	41
16. Estimates of Relative Stock Density (RSD) by location for Arctic grayling in the upper sections of the Tangle Lakes and River system, Alaska, 1988.....	42
17. Monthly estimates of the contributions of each age class of Arctic grayling in the Tangle Lakes and River system, 1988.....	43
18. Estimates of the contributions of each age class, by location, of Arctic grayling in the Tangle Lakes and River system, 1988.....	44
19. Estimates of the contributions of each age class, by location, of Arctic grayling in the middle sections of the Tangle Lakes and River system, 1988.....	45
20. Estimates of the contributions of each age class, by location, of Arctic grayling in the upper sections of Tangle Lakes and River system, 1988.....	46
21. Monthly estimates of mean fork length-at-age (mm) of Arctic grayling in the Tangle Lakes and River system, Alaska, 1988.....	47
22. Estimates of mean fork length-at-age (mm) of Arctic grayling in the Delta River and the lower sections of the Tangle Lakes and River system, Alaska, 1988.....	48

LIST OF TABLES (Continued)

<u>Table</u>	<u>Page</u>
23. Estimates of mean fork length-at-age (mm) of Arctic grayling in the middle sections of the Tangle Lakes and River system, Alaska, 1988.....	49
24. Estimates of mean fork length-at-age (mm) of Arctic grayling in the upper sections of the Tangle Lakes and River system, Alaska, 1988.....	50

## LIST OF FIGURES

<u>Figure</u>	<u>Page</u>
1. Map of the Tangle Lakes and River system, Alaska.....	3
2. Length frequency of Arctic grayling in the Tangle Lakes and River system, Alaska, 1986.....	11
3. Comparison of length frequencies, by gear type, of Arctic grayling in the Tangle Lakes and River system, Alaska, 1986.....	12
4. Comparison of length frequencies of Arctic grayling in Shallow Tangle Lake and thoroughfare between Shallow and Round Tangle Lakes, Alaska, 1986.....	13
5. Comparison of length frequencies of Arctic grayling caught in the sport fishery at Round Tangle Lake, Tangle River, and Upper Tangle Lake, Alaska, 1986.....	14
6. Comparison of length frequencies for Arctic grayling in the Tangle Lakes and River system and Tangle River, Alaska, 1987.....	22
7. Comparison of length frequencies of Arctic grayling caught during June and August in the Tangle River, Alaska 1987.....	23
8. Length frequency of Arctic grayling in the Tangle Lakes and River system, Alaska, 1988.....	30
9. Comparison of length frequencies of Arctic grayling caught by various gear types in the Tangle Lakes and River system, Alaska, 1988.....	31
10. Comparison of length frequencies of Arctic grayling caught during June, July, August, and September in the Tangle Lakes and River system, Alaska, 1988.....	32
11. Comparison of length frequencies of Arctic grayling caught downstream and upstream of the falls in the Delta River, Alaska, 1988.....	33
12. Comparison of length frequencies of Arctic grayling caught in the lower sections of the Tangle Lakes and River system, Alaska, 1988.....	34
13. Comparison of length frequencies of Arctic grayling in Round and Upper Tangle Lakes, Alaska, 1988.....	35



LIST OF FIGURES (Continued)

<u>Figure</u>	<u>Page</u>
14. Comparison of length frequencies of Arctic grayling in the Tangle River and Upper Tangle River, Alaska, 1988..	36
15. Comparison of length frequencies of Arctic grayling in Landmark Gap Creek, Clear and 18 Mile Creeks, and Rock Creek, Alaska, 1988.....	38

# ABSTRACT

In 1988, a comprehensive study was undertaken to assess the mixing rates of Arctic grayling *Thymallus arcticus* among their major spawning, summer-rearing, and over-wintering areas in the Tangle Lakes and River system, hereafter referred to as the Tangle System. Previous studies in the Tangle System had been limited to specific areas within the system. This study was intended to assess the status of Arctic grayling throughout the system. Preliminary tagging studies had been conducted in 1986 and 1987. Tagging data are presented from sampling trips conducted during 1986, 1987, and 1988. For all three years, length frequencies, relative stock densities, age compositions, and mean fork length-at-age were determined.

From 1986 to 1988, 9,537 Arctic grayling were captured in the Tangle System with 5,226 Arctic grayling marked with individually-numbered Floy anchor tags. During this time, 199 Arctic grayling were recaptured. Arctic grayling captured in the Tangle System ranged in fork length from 50 to 397 millimeters and ranged in age from 0 to 9 years. Insufficient recaptures across years prevented reliable estimation of mixing rates of Arctic grayling among different areas of the Tangle System.

KEY WORDS: Arctic grayling, *Thymallus arcticus*, Tangle Lakes, Tangle River, Delta River, age composition, size composition, Relative Stock Density, mixing rates.

## INTRODUCTION

The Tangle Lakes and River system, hereafter referred to as the Tangle System (Figure 1), supports a large population of Arctic grayling *Thymallus arcticus* and populations of lake trout *Salvelinus namaycush*, burbot *Lota lota*, round whitefish *Prosopium cylindraceum*, and longnose suckers *Catostomus catastomus*. The Tangle System has supported popular fisheries for Arctic grayling, lake trout, and burbot since the construction of the Denali Highway in the 1950's. Prior to this time, the Tangle System was inaccessible by road and received little fishing pressure (Wojcik 1953a, 1953b, 1953c, 1953d, 1953e, 1953f, 1953g). Since 1953, the heaviest angling pressure has occurred on Upper and Round Tangle lakes and the interconnecting Tangle River (Figure 1).

From 1978 to 1986, an average of 6,329 angler-days were expended annually to harvest 5,962 Arctic grayling, 988 lake trout, 189 whitefish, and 109 burbot (Mills 1979-1987). In the past few years, increasing levels of sport harvest of lake trout and burbot necessitated closure of these fisheries by emergency order in 1987. These closures appear to have indirectly affected the harvest of Arctic grayling in the Tangle System. In 1987, angling pressure dropped to 2,530 angler-days and harvest was reduced to 2,467 Arctic grayling (Mills 1988).

Since 1953, numerous studies have been conducted to assess the population structure of Arctic grayling in the Tangle System (Wojcik 1953a, 1953b, 1953c, 1953d, 1953e, 1953f, 1953g; Warner 1955a, 1955b, 1956, 1957, 1958, 1959; Heckart 1965; Roguski 1967; Roguski and Winslow 1969; Roguski and Tack 1970; Schallock 1966; Peckham 1974, 1977; Holmes et al. 1986; Clark and Ridder 1987; and Baker 1988). The majority of these studies have been limited to specific areas of the system and for the most part are not comparable from year to year. However, some basic conclusions about Arctic grayling population(s) can be made from these studies.

Arctic grayling migrate throughout the Tangle System. In the spring, Arctic grayling concentrate at the mouths of streams. When ready to spawn, the Arctic grayling move up the streams. After spawning, fish move into the rivers and thoroughfares between the lakes for the summer. In the fall before ice-up, the fish move back to main lakes where they over winter. (Wojcik 1953d; Warner 1955; Schallock 1966). There are indications that separate populations or stocks of Arctic grayling exist in the Tangle System. Based on tagging studies, the majority of Arctic grayling move to the same spring spawning sites and summer feeding sites. However, this segregation appears to occur only in the spring and summer (Schallock 1966).

Because no comprehensive research has been conducted on the Tangle System Arctic grayling, a research project was initiated in 1988 to assess the stock status of Arctic grayling in the Tangle System. The specific objectives of this research project were to estimate:

- 1) the mixing rates of Arctic grayling among their major spawning, summer-rearing, and over-wintering areas in the Tangle System;

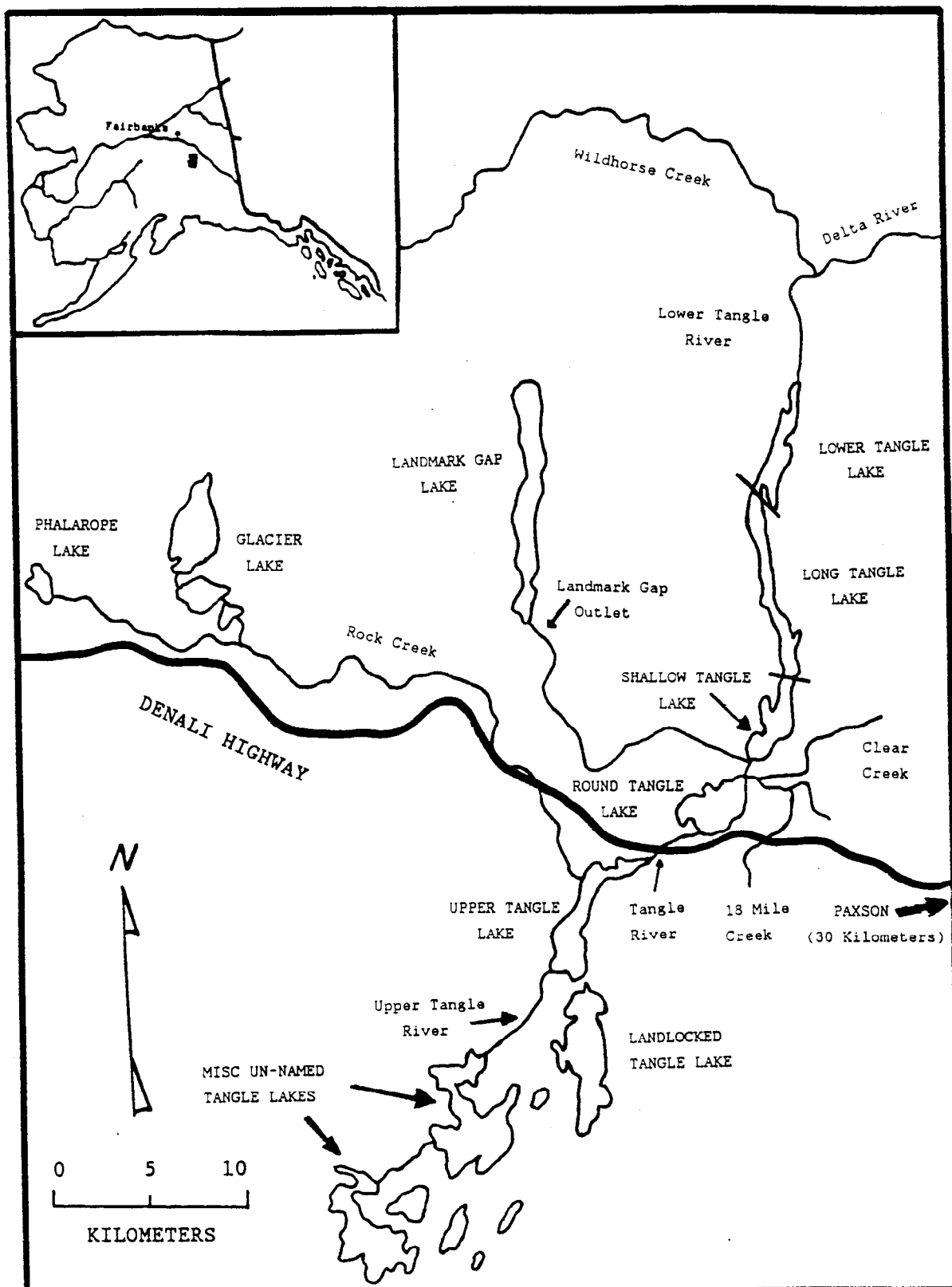


Figure 1. Map of the Tangle Lakes and River system, Alaska.

- 2) the percent age composition for each age class of mature fish in the Arctic grayling population(s) in the Tangle System;
- 3) the percent Relative Stock Density for each of the five length categories of mature fish in the Arctic grayling population(s) in the Tangle System; and,
- 4) the mean fork length of each age class of mature fish in the Arctic grayling population(s) in the Tangle System.

Preliminary results of this research along with data collected in the Tangle System during 1986 and 1987 are presented in this paper.

#### STUDY SITE

The Tangle Lakes and River system is a lake-river-stream system located approximately 37 km west of Paxson on the Denali Highway (Figure 1). The Denali Highway bisects the system at the Tangle River between Round and Upper Tangle lakes. There are two Bureau of Land Management (BLM) campgrounds located next to the highway at the two lakes. The system contains approximately 225 km of rivers and streams, and 21 major lakes (Carlton 1976). The Tangle System is approximately 900 m in elevation. The maximum depth of the lakes is 35 m in Round Tangle Lake. The lakes within the system cumulatively cover a surface area of over 725 ha. The open-water season in the Tangle System is about four months (middle of June to the middle of October). However, some open water persists all year at the inlets and outlets of rivers and streams.

The system is made up of five main lakes (Lower, Long, Shallow, Round, and Upper Tangle lakes) that are interconnected by the Tangle River. At the headwaters of the Tangle System above Upper Tangle Lake, there is a series of un-named lakes where the Tangle River originates. There are also three lakes that interconnect into the four main lakes. Phalarope and Glacier Lakes flow into Upper Tangle Lake through Rock Creek. Landmark Gap Lake flows into a thoroughfare between Round and Shallow Tangle lakes.

The Tangle System is also the beginning of a popular float trip that runs 40 km through the Tangle System and extends 33 km downstream on the Delta River (Figure 1). The Alaska National Lands Conservation Act of 2 December 1980, established the upper Delta River, and Tangle Lakes and River (Round, Shallow, Long, and Lower Tangle lakes) as a component of the National Wild and Scenic River System.

#### METHODS

##### 1986 Field Study

Sampling of the Tangle System in 1986 consisted of two parts: (1) sampling the sport fishery harvest with a creel census; and (2) field sampling. A creel clerk was stationed at the Tangle Lakes to conduct a creel census from

July through August 1986. The field sampling consisted of one sampling trip from 4-6 September 1986. The field crew used a DC powered electrofishing boat and beach seines to capture the Arctic grayling.

#### 1987 Field Study

In 1987, field sampling consisted of two sampling trips. The first sampling trip was conducted during 20 - 23 June 1987. The second trip was conducted during 21 - 28 August 1987. The majority (1,183) of the Arctic grayling were captured in the Tangle River. The rest of the sampled Arctic grayling were captured throughout the Tangle System from the thoroughfare (between Long and Shallow Tangle lakes) upstream to Upper Tangle Lake. The majority of Arctic grayling were captured with a beach seine; a few were captured with a purse seine and by electrofishing.

#### 1988 Field Study

The primary goal in 1988 was to tag as many Arctic grayling as possible throughout the entire Tangle System. Field studies were conducted from 3 June through 16 September 1988. Arctic grayling were captured with a number of different gear types that included gill nets, electrofishing (boat, backpack, and shore based units), beach seines, purse seines, fyke nets, and hook-and-line gear.

#### June Sampling:

During the month of June, the majority of sampling effort was expended in the upper and middle sections of the Tangle System. In the first two weeks, fyke nets were placed in the lower portions of Landmark Gap Creek, Clear Creek, Tangle River, Rock Creek, and Upper Tangle River. It was believed the fyke nets could capture the Arctic grayling as they migrated from the lakes to the creeks to spawn or as the fish were returning from the creeks after spawning. The fyke nets were set in the creeks to capture Arctic grayling migrating either upstream or downstream. Fyke nets had little success in capturing adult Arctic grayling. The fyke nets, however, did catch varying numbers of small Arctic grayling with a large number of small Arctic grayling being caught in the Tangle River and Round Tangle Lake. The fyke nets were checked twice daily to prevent stressing the captured fish and to clean the nets of debris. The last two weeks of June were spent beach seining and purse seining in the lakes throughout the Tangle System. The best success occurred in upper Tangle Lake using the purse seine as a beach seine. Approximately 300 Arctic grayling were captured. The Arctic grayling were congregating off the mouth of Rock Creek, a tributary to the lake. A small number of fish were also captured in Round Tangle Lake near the mouth of the Tangle River. Again, the most effective technique was using the purse seine as a beach seine. Little or no success resulted from the smaller beach seine or using the purse seine as a true purse seine. During the entire month of June approximately 200 Arctic grayling were caught in gill nets by the crew from the lake trout research study. However, approximately half of these fish died due to stress of the gill nets.

#### July Sampling:

In July, sampling shifted to the lower portion of the Tangle System and creeks throughout the Tangle System. The Delta River was sampled via a float trip. From 14 - 18 July 1988, approximately 1,110 Arctic grayling were sampled in the Delta River above and below the falls. The majority of the fish were captured by hook-and-line gear (fly fishing). The various creeks that included Landmark Gap Creek, Clear Creek, Rock Creek, and the Upper Tangle River were sampled with both back-pack and shore-based electrofishing gear, small beach seines (16 m long X 2 m deep), and hook-and-line gear. The back-pack electrofishing units did not have enough power to sample the creeks. The shore-based electrofishing unit was too cumbersome to get to the majority of the streams. Beach seining had marginal success in the slower moving water of the creeks. The most successful method was hook-and-line gear.

#### August Sampling:

Sampling was spread throughout the entire Tangle System during the month of August. Two sampling crews were used during a portion of the month of August. The first crew sampled the Delta River downstream of the falls during the third week of August. Approximately 1,200 Arctic grayling were sampled. Approximately half of the fish sampled were captured by hook-and-line gear and half by a DC pulse electrofishing boat. The second crew spent the majority of the month sampling Landmark Gap Creek, Rock Creek, and the Upper Tangle River. Approximately 300 Arctic grayling were sampled in each of the three areas using hook-and-line gear. During the last week of August, all of the Tangle Lakes except Lower Tangle Lake was electrofished using a boat. A DC pulse electrofishing boat was used at night along the shore of all the major lakes. Very few Arctic grayling were captured using the electrofishing boat.

#### September Sampling:

Sampling consisted of a float trip on the Delta River and beach seining in the Tangle River. The Delta River float trip was conducted from 1 - 4 September 1988. Approximately 400 Arctic grayling were sampled in the Delta River upstream of the falls. All of the fish were captured with hook-and-line gear. Fishing success was very limited downstream of the falls. It appeared the majority of the Arctic grayling that were in the Delta River earlier in the summer had emmigrated. Beach seining was conducted in the Tangle River on 15 - 16 September. Approximately 1,000 Arctic grayling were sampled.

All anglers encountered during sampling were interviewed in the Tangle System. All harvested fish were checked for tags.

#### Data Collection

All Arctic grayling captured were measured to the nearest 1 mm fork length (FL) and scales taken from an area above the lateral line just posterior to the insertion of the dorsal fin. Scale samples were placed in a coin envelope marked with the appropriate litho code and fish number. Arctic grayling greater than 199 mm in fork length (FL) were tagged with an individually-numbered Floy internal anchor tag and the adipose fin was clipped to determine

tag loss. Locations, dates, and times of all sampling methods utilized (trap net, gill net, seine, electrofishing gear, and hook-and-line) were recorded on a field data form and marked on a map.

#### Estimation of Mixing Rates

The entire Tangle System was systematically sampled from the beginning of June through the middle of September. The release and recapture of tagged fish was to allow the tracking of movement of Arctic grayling throughout the sampling time. Temporal and spatial mixing rates were to be estimated from the tagging information. A mixing rate was the probability that a fish tagged and released in Area A during Time B was recovered in Area C during Time D. Mixing rate can be treated as a Markov chain, such that the cell in the transition matrix is an element of a multinomial proportion:

		Recapture:		
		Area		
Release:		A	B	C
Area				
A	[	.5	.2	.3
B		.1	.7	.2
C		.3	.3	.4

Information in Thompson (1987) was used to estimate how many tags must be recovered to meet the objective criteria. The number of recoveries would determine the accuracy and precision of the estimates. The number of tag recoveries were dependent upon the amount of sampling effort, Arctic grayling population size, the effectiveness of sampling techniques, and the number of areas within the Tangle System. Based upon Thompson (1987), approximately 400 tag recoveries were needed to meet the objective criteria set in the operational plan.

#### Estimation of Relative Stock Density (RSD)

Relative Stock Density (RSD; Gabelhouse 1984) was estimated for all areas of the Tangle System. The five RSD length categories ( $RSD_j$ ) were estimated as:

$$(3) \quad \hat{RSD}_j = \frac{n_j}{n_{RSD}} * 100,$$

where:  $n_j$  = number of Arctic grayling sampled that are within RSD length category j; and,

$n_{RSD}$  = total number of Arctic grayling sampled that are greater than 149 mm FL (minimum stock size).



The unbiased variance of this percent  $V[\hat{RSD}_j]$  was estimated as:

$$(4) \quad V[\hat{RSD}_j] = \frac{\hat{RSD}_j(100-\hat{RSD}_j)}{n_{RSD} - 1}.$$

The five RSD categories for Arctic grayling were set at: (1) "stock" 150 mm to 269 mm FL; (2) "quality" 270 mm to 339 mm FL; (3) "preferred" 340 mm to 449 mm FL; (4) "memorable" 450 mm to 559 mm FL; and (5) "trophy" 560 mm FL and greater.

#### Estimation of Age Composition

Arctic grayling samples within the same geographic area were combined to estimate percent age composition. Criteria developed for multinomial distributions by Thompson (1987) indicated that 510 fish must be aged from each discrete population of fish to obtain precise estimates of age composition. The percent age composition for each age class ( $AC_a$ ) was estimated as:

$$(1) \quad AC_a = \frac{n_a}{n_{AC}} * 100,$$

where:  $n_a$  = number of Arctic grayling sampled that are age a; and,

$n_{AC}$  = total number of Arctic grayling sampled that age is estimated for.

The unbiased variance of this percent  $V[\hat{AC}_a]$  was estimated as:

$$(2) \quad V[\hat{AC}_a] = \frac{\hat{AC}_a(100-\hat{AC}_a)}{n_{AC} - 1}.$$

#### Estimation of Mean Fork Length-at-Age

Mean fork length-at-age was estimated for all areas of the Tangle System. Because all means were assumed to be distributed normally (according to the Central Limit Theorem), simple means and squared deviations from the mean were used to estimate mean fork length-at-age ( $FL_a$ ) as:

$$(5) \quad \hat{\overline{FL}}_a = \frac{\sum_{i=1}^{n_{al}} FL_{ai}}{n_{al}},$$

where:  $FL_{ai}$  = fork length (mm) of Arctic grayling  $i$  that is sampled and age  $a$ ; and,

$n_{al}$  = number of Arctic grayling sampled for length that are age  $a$ .

The variance of this mean  $V[\hat{\overline{FL}}_a]$  was estimated as:

$$(6) \quad V[\hat{\overline{FL}}_a] = \frac{\sum_{i=1}^{n_{al}} (FL_{ai} - \hat{\overline{FL}}_a)^2}{n_{al}(n_{al} - 1)}.$$

## RESULTS AND DISCUSSION

### 1986 Results

The creel clerk sampled 243 Arctic grayling from the sport fishery (Table 1). A total of 567 Arctic grayling were sampled in the thoroughfare between Shallow and Round Tangle Lakes, Round Tangle Lake, Tangle River, and Upper Tangle Lake.

#### Length Frequencies:

Arctic grayling captured in the Tangle Lakes in 1986 ranged in fork length from 60 mm up to 370 mm (Figure 2). The three types of capture gear used in 1986 caught very different size classes of Arctic grayling. The sport fishery (hook-and-line gear) produced much larger fish than either beach seining or boat electrofishing (Figure 3). It is unknown whether larger fish captured in the sport fishery are a result of anglers targeting for larger fish or selectivity of hook and line gear. Comparison of length frequencies indicate that smaller Arctic grayling inhabit the thoroughfare between Shallow and Round Tangle Lakes than in Shallow Tangle Lake itself (Figure 4). Length frequencies of Arctic grayling caught in the sport fishery were compared. The largest Arctic grayling were caught in Upper Tangle Lake followed by the Tangle River and Round Tangle Lake (Figure 5).

#### Relative Stock Density:

The majority of the Arctic grayling captured in the Tangle System during 1986 were in the stock (76.8%), and quality (18.2%) length categories with a small percent (5.0%) in the preferred length category (Table 2). No Arctic grayling were in the memorable or trophy length categories. Relative Stock Density, by

Table 1. Summary of Arctic grayling caught, marked, and recaptured in the Tangle Lakes and River system, Alaska, July through September 1986.

Location	Location Code	Number Caught	Number Marked	Number Recaptured			
				1986	1987	1988	Total
Shallow Tangle Lake	300	351	180	1	-	-	1
Thoroughfare (Shallow & Round)	350	82	26	0	-	-	0
Round Tangle Lake	400	84	0	0	-	-	0
Tangle River	500	119	0	0	-	-	0
Upper Tangle Lake	600	174	11	0	-	-	0
Total	-	810	217	1	-	-	1
Date Summary							
June	-	0	0	0	-	-	0
July	-	136	0	0	-	-	0
August	-	107	0	0	-	-	0
September	-	567	217	1	-	-	1
Total	-	810	217	1	-	-	1
Gear Type Summary							
Seine	-	433	206	1	-	-	1
Electrofishing	-	134	11	0	-	-	0
Sport Fishery	-	243	0	0	-	-	0
Total For 1986	-	810	217	1	-	-	1

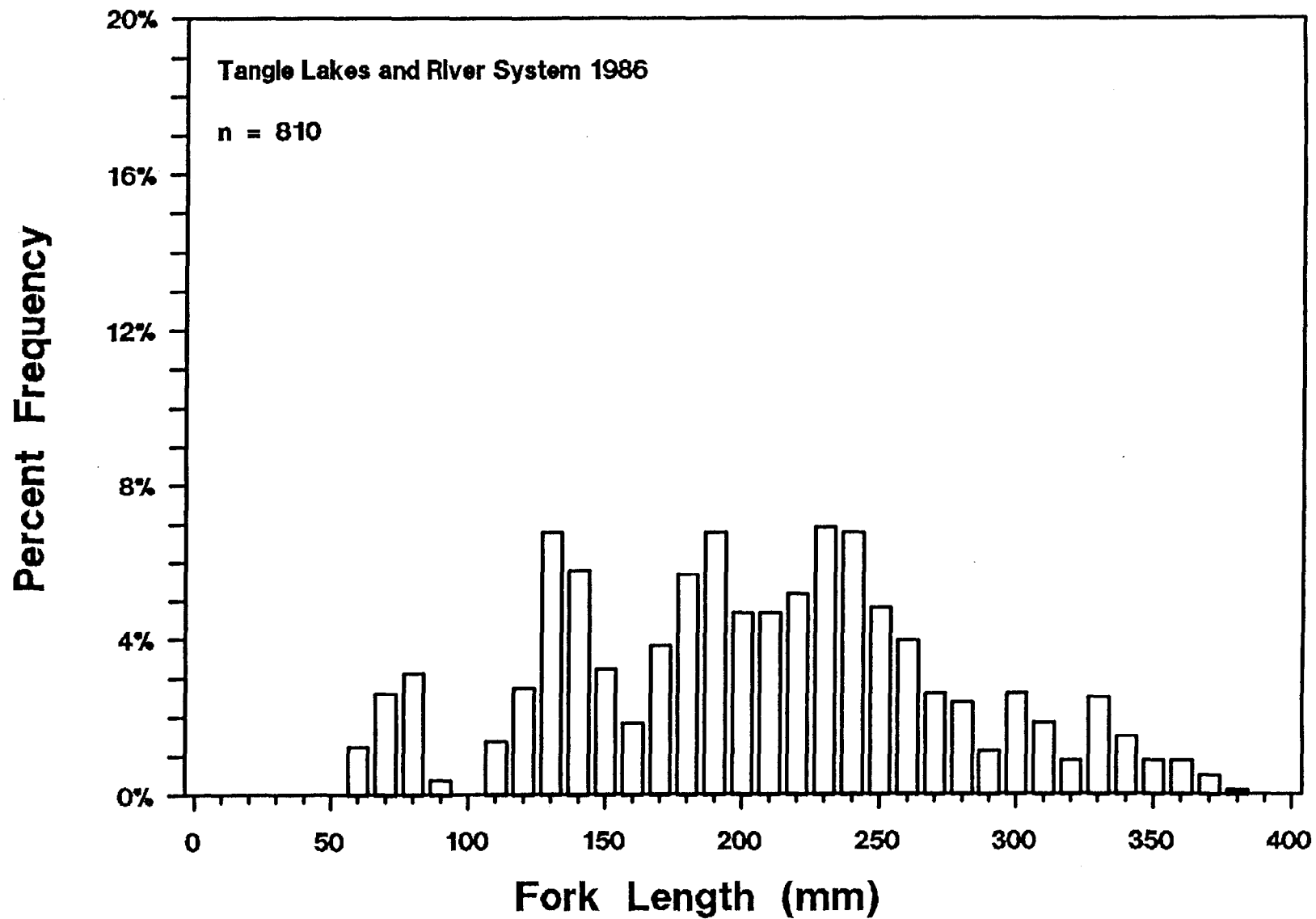


Figure 2. Length frequency of Arctic grayling in the Tangle Lakes and River system, Alaska, 1986.

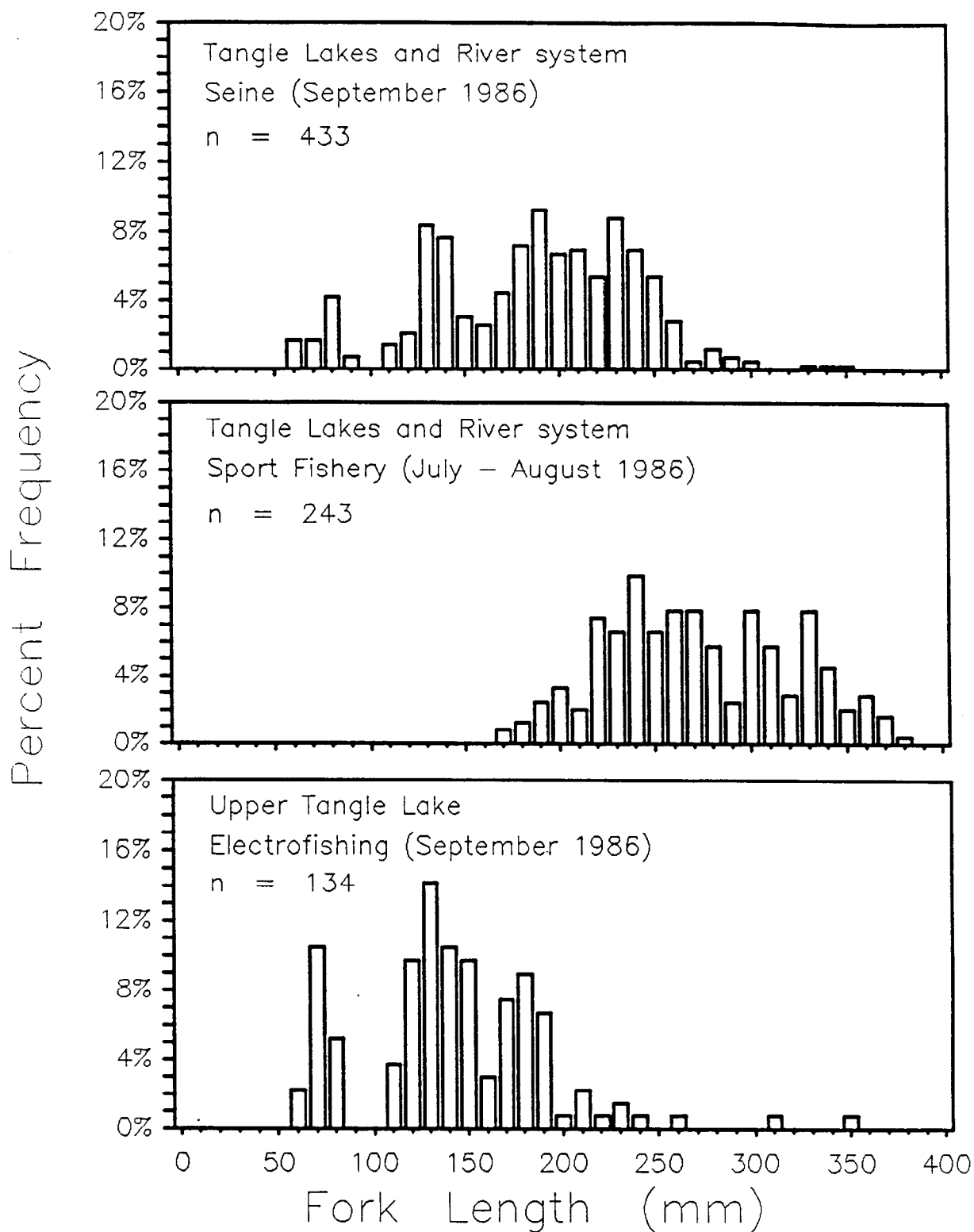


Figure 3. Comparison of length frequencies, by gear type, of Arctic grayling in the Tangle Lakes and River system, Alaska, 1986.

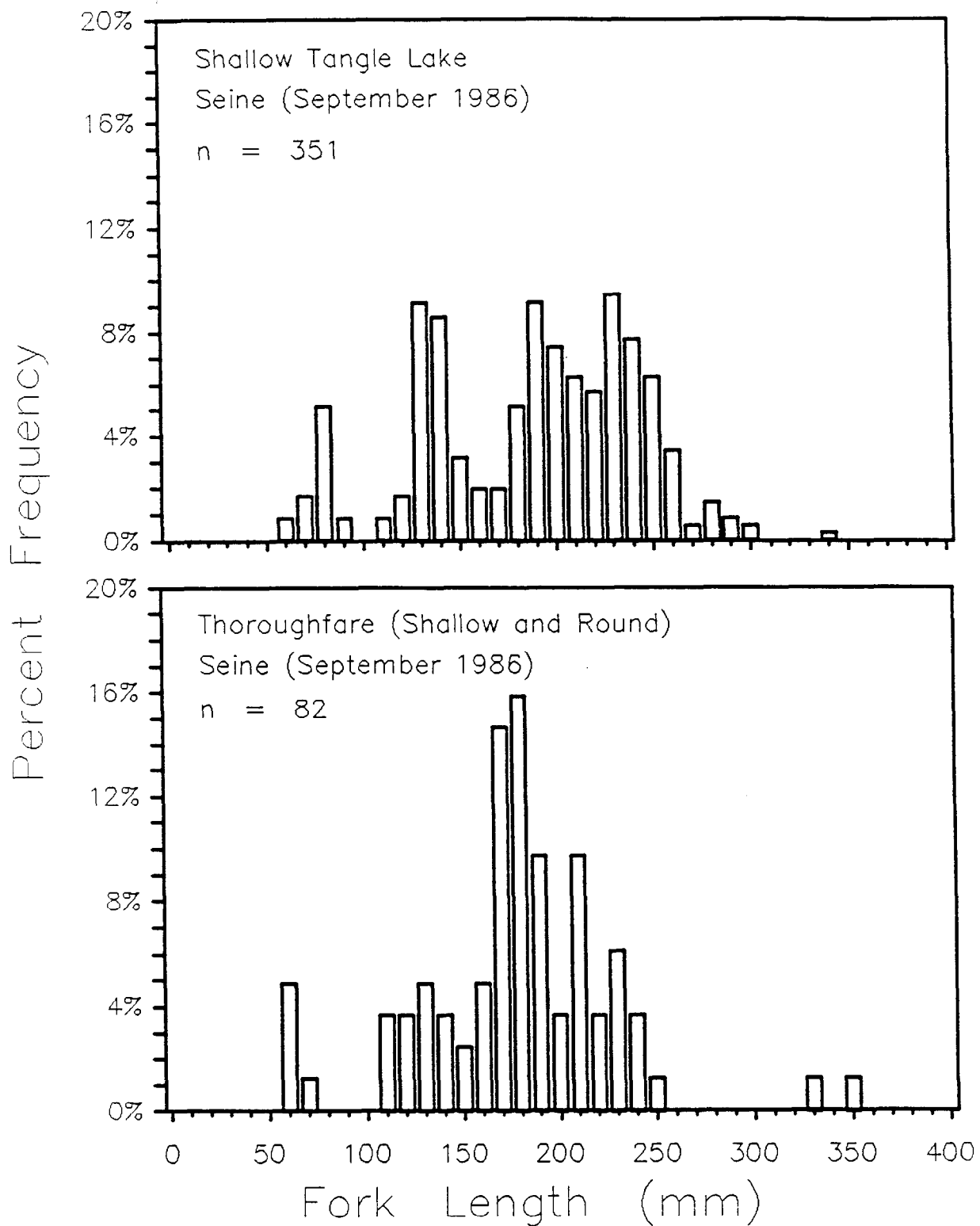


Figure 4. Comparison of length frequencies of Arctic grayling in Shallow Tangle Lake and thoroughfare between Shallow and Round Tangle Lakes, Alaska, 1986.

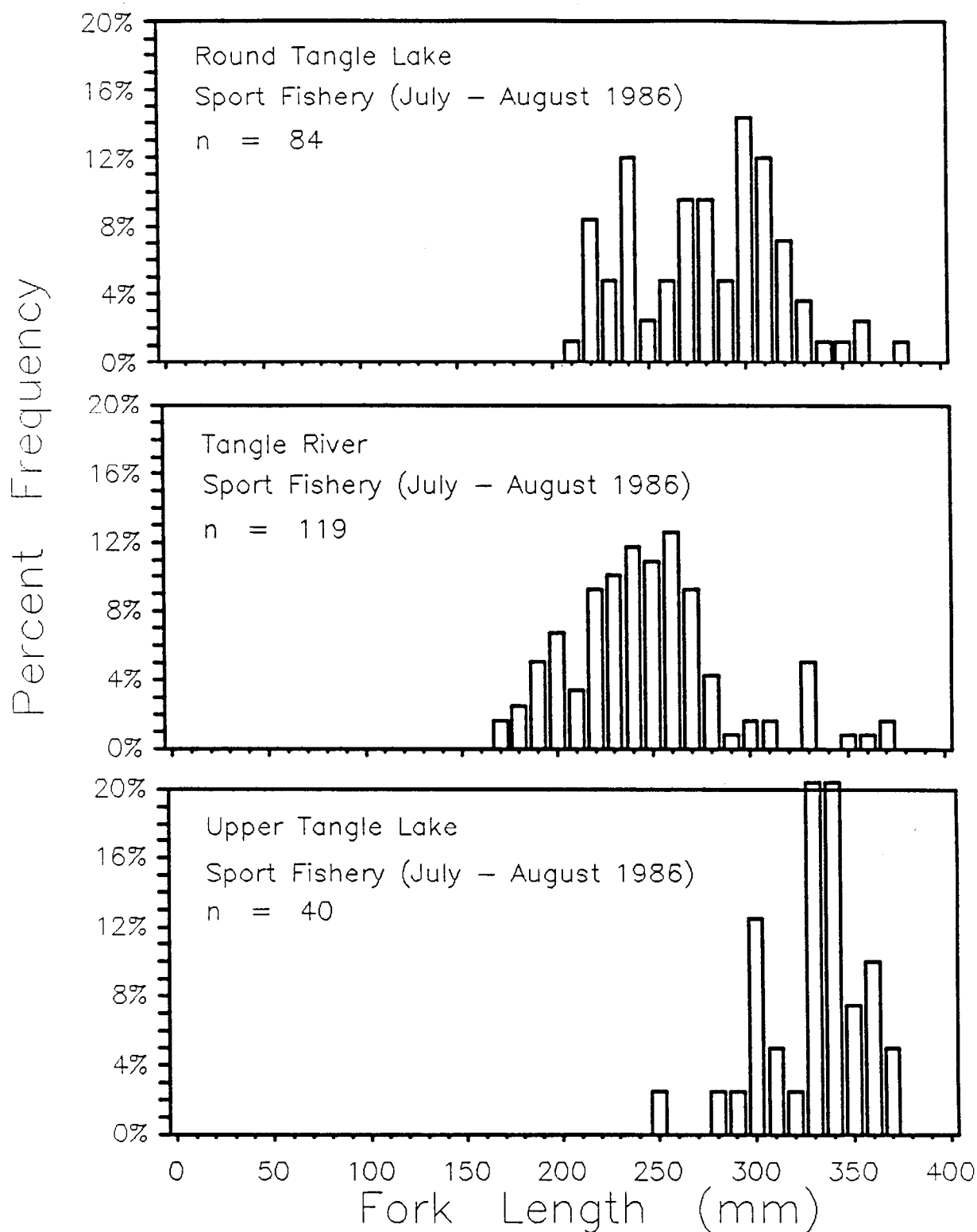


Figure 5. Comparison of length frequencies of Arctic grayling caught in the sport fishery at Round Tangle Lake, Tangle River, and Upper Tangle Lake, Alaska, 1986.

Table 2. Estimates of Relative Stock Density (RSD) by gear type for Arctic grayling in the Tangle Lakes and River system, Alaska, July through September 1986.

Category	Fork Length Range (mm)	Tangle Lakes and River system 1986											
		Combined			Seine			Electrofishing			Sport Fishery		
		n	%	SE	n	%	SE	n	%	SE	n	%	SE
Stock	150-269	473	76.8	1.7	299	95.2	1.2	57	96.6	2.4	117	48.1	3.2
Quality	270-339	112	18.2	1.6	13	4.1	1.1	1	1.7	1.7	98	40.3	3.2
Preferred	240-449	31	5.0	0.9	2	0.6	0.4	1	1.7	1.7	28	11.5	2.1
Memorable	450-559	0	0.0	-	0	0.0	-	0	0.0	-	0	0.0	-
Trophy	560-up	0	0.0	-	0	0.0	-	0	0.0	-	0	0.0	-
Total		616			314			59			243		



capture gear, indicate hook-and-line-gear was more selective for larger Arctic grayling. Approximately 95% of Arctic grayling captured in Shallow Tangle Lake and thoroughfare between Shallow and Round Tangle lakes were of stock size while only 2.5% of the fish caught in Upper Tangle Lake were of stock size (Table 3). The number of Arctic grayling caught in Upper Tangle Lake were almost evenly split between quality and memorable length categories.

#### Age Composition:

Arctic grayling captured in the Tangle System during 1986 ranged in age from 0 to 8 years (Table 4). The largest percentage (34.0%) were age 3, followed by age 2 (22.2%), age 1 (14.3%), and age 4 at 11.1%. All the other ages comprised less than 10% of the Arctic grayling captured. Age compositions were also determined for each type of capture used during 1986. The sport fishery was much more selective for older Arctic grayling than seines or electrofishing boat. Age compositions of fish captured with a seine net from Shallow Tangle Lake and the thoroughfare between Shallow and Round Tangle Lake were somewhat similar (Table 5). However, age compositions of Arctic grayling captured in the sport fishery indicates older Arctic grayling in Upper Tangle Lake than Round Tangle Lake or the Tangle River (Table 5).

#### Mean Fork Length-at-Age:

Mean fork length-at-age was determined for all age classes of Arctic grayling captured (Table 6). Arctic grayling show steady growth throughout their life span. Mean fork length-at-age was determined for the different sampling areas in the Tangle System. No trends can be seen between the different areas. This was probably due to smaller sample sizes in the selective areas.

#### 1987 Results

A total of 1,328 Arctic grayling were sampled during two trips (Table 7).

#### Length Frequencies:

Length frequencies for the Tangle River and Arctic grayling captured in all other areas in 1987 were similar (Figure 6). This is because the majority of Arctic grayling were actually captured in the Tangle River. Arctic grayling captured in the Tangle River were slightly larger in August than in June 1988, which may indicate growth during the summer (Figure 7).

#### Relative Stock Density:

The majority of Arctic grayling (over 150 mm) captured in the Tangle System during 1987 were of stock size (87.6%) followed by quality size (11.6%) with a very small percent (0.8%) in the preferred size category (Table 8). No Arctic grayling were in the memorable or trophy length categories. Relative Stock Densities, by month of capture, were similar for Arctic grayling captured in the Tangle River. There were a larger percentage of quality size Arctic grayling in the Tangle River in August than in June (Table 8).

Table 3. Estimates of Relative Stock Density (RSD) by area for Arctic grayling in the Tangle Lakes and River system, Alaska, July through September 1986.

Category	Fork Length Range (mm)	Seine Only						Sport Fishery Only								
		Shallow Tangle Lake			Thoroughfare (Shallow and Round)			Round Tangle Lake			Tangle River			Upper Tangle River		
		n	%	SE	n	%	SE	n	%	SE	n	%	SE	n	%	SE
Stock	150-269	237	94.8	1.4	62	96.9	2.2	28	33.3	5.2	88	73.9	4.0	1	2.5	2.5
Quality	270-339	12	4.8	1.4	1	1.6	1.6	51	60.7	5.4	27	22.7	3.9	20	50.0	8.0
Preferred	240-449	1	0.4	0.4	1	1.6	1.6	5	6.0	2.6	4	3.4	1.7	19	47.5	8.0
Memorable	450-559	0	0.0	-	0	0.0	-	0	0.0	-	0	0.0	-	0	0.0	-
Trophy	560-up	0	0.0	-	0	0.0	-	0	0.0	-	0	0.0	-	0	0.0	-
Total		250			64			84			119			40		

Table 4. Estimates of the contributions of each age class of Arctic grayling, for each gear type used in the Tangle Lakes and River system, Alaska, July through August 1986.

Tangle Lakes and River system 1986												
Age	Combined			Seine			Electrofishing			Sport Fishery		
	n	%	SE	n	%	SE	n	%	SE	n	%	SE
0	35	5.3	0.9	35	8.1	1.3	24	18.0	3.3	0	0.0	-
1	94	14.3	1.4	94	21.7	2.0	60	45.1	4.3	0	0.0	-
2	146	22.2	1.6	130	30.0	2.2	41	30.8	4.0	16	7.1	1.7
3	224	34.0	1.8	144	33.3	2.3	6	4.5	1.8	80	35.6	3.2
4	73	11.1	1.2	24	5.5	1.1	1	0.8	0.8	49	21.8	2.8
5	38	5.8	0.9	3	0.7	0.4	0	0.0	-	35	15.6	2.4
6	33	5.0	0.9	2	0.5	0.3	1	0.8	0.8	31	13.8	2.3
7	14	2.1	0.6	1	0.2	0.2	0	0.0	-	13	5.8	1.6
8	1	0.2	0.2	0	0.0	-	0	0.0	-	1	0.4	0.4
Total	658			433			133			225		

Table 5. Estimates of the contributions of each class of Arctic grayling for each location sampled in the Tangle Lakes and River system, Alaska, July through August 1986.

Age	Seine Only						Sport Fishery Only								
	Shallow Tangle Lake			Thoroughfare (Shallow and Round)			Round Tangle Lake			Tangle River			Upper Tangle River		
	n	%	SE	n	%	SE	n	%	SE	n	%	SE	n	%	SE
0	30	8.5	1.5	5	6.1	2.7	0	0.0	-	0	0.0	-	0	0.0	-
1	80	22.8	2.2	14	17.1	4.2	0	0.0	-	0	0.0	-	0	0.0	-
2	91	25.9	2.3	39	47.6	5.5	1	1.3	1.3	15	13.2	3.2	0	0.0	-
3	124	35.3	2.6	20	24.4	4.8	23	28.7	5.1	56	49.1	4.7	1	3.2	3.2
4	22	6.3	1.3	2	2.4	1.7	21	26.3	5.0	25	21.9	3.9	3	9.7	5.4
5	3	0.9	0.5	0	0.0	-	20	25.0	4.9	9	7.9	2.5	6	19.4	7.2
6	1	0.3	0.3	1	1.2	1.2	12	15.0	4.0	6	5.3	2.1	13	41.9	9.0
7	0	0.0	-	1	1.2	1.2	2	2.5	1.8	3	2.6	1.5	8	25.8	8.0
8	0	0.0	-	0	0.0	-	1	1.3	1.3	0	0.0	-	0	0.0	-
Total	351			82			80			114			31		

Table 6. Estimates of mean fork length-at-age (mm) of Arctic grayling in the Tangle Lakes and River system, Alaska, July through September 1986.

				Seine Only						Sport Fishery Only								
				Shallow Tangle Lake			Thoroughfare (Shallow & Round)			Round Tangle Lake			Tangle River			Upper Tangle Lake		
Age	n	Mean	SE	n	Mean	SE	n	Mean	SE	n	Mean	SE	n	Mean	SE	n	Mean	SE
0	59	79	1	30	82	1	5	67	2	0	-	-	0	-	-	24	76	1
1	154	137	1	80	138	1	14	132	3	0	-	-	0	-	-	60	137	1
2	187	190	1	91	191	1	39	182	2	1	221	-	15	200	5	41	181	2
3	230	235	1	124	236	1	20	222	3	23	238	3	56	235	3	7	246	16
4	74	272	2	22	267	5	2	244	2	21	283	4	25	268	2	4	289	12
5	38	305	3	3	284	4	0	-	-	20	307	3	9	297	10	6	319	7
6	34	335	2	1	343	-	1	336	-	12	327	4	6	337	8	14	343	3
7	14	359	3	0	-	-	1	355	-	2	365	3	3	371	7	8	353	4
8	1	380	-	0	-	-	0	-	-	1	380	-	0	-	-	0	-	-
Total 791				351			82			80			114			164		

Table 7. Summary of the number of Arctic grayling caught, marked, and recaptured in the Tangle Lakes and River system, Alaska, during 1987.

Location	Location Code	Number Caught	Number Marked	Number Recaptured			
				1986	1987	1988	Total
Location Summary							
Thoroughfare (Long and Shallow)	275	86	71	0	0	-	0
Clear Creek (DS of 18 Mile Cr)	381	2	2	0	0	-	0
Round Tangle Lake	400	23	22	0	0	-	0
Round Tangle Lake (Near Mouth)	490	10	10	0	1	-	1
Tangle River (DS of Denali Hghwy)	501	745	342	5	8	-	13
Tangle River (US of Denali Hghwy)	502	438	126	8	0	-	8
Upper Tangle Lake	600	24	17	0	0	-	0
Total	-	1,328	590	13	9	-	22
Date Summary							
June	-	574	271	8	1	-	9
July	-	0	0	0	0	-	0
August	-	754	319	5	8	-	13
September	-	0	0	0	0	-	0
Total	-	1,328	590	13	9	-	22
Sampling Gear Summary							
Seine	-	1,294	563	13	9	-	22
Electrofishing (Boat)	-	34	27	0	0	-	0
Total	-	1,328	590	13	9	-	22

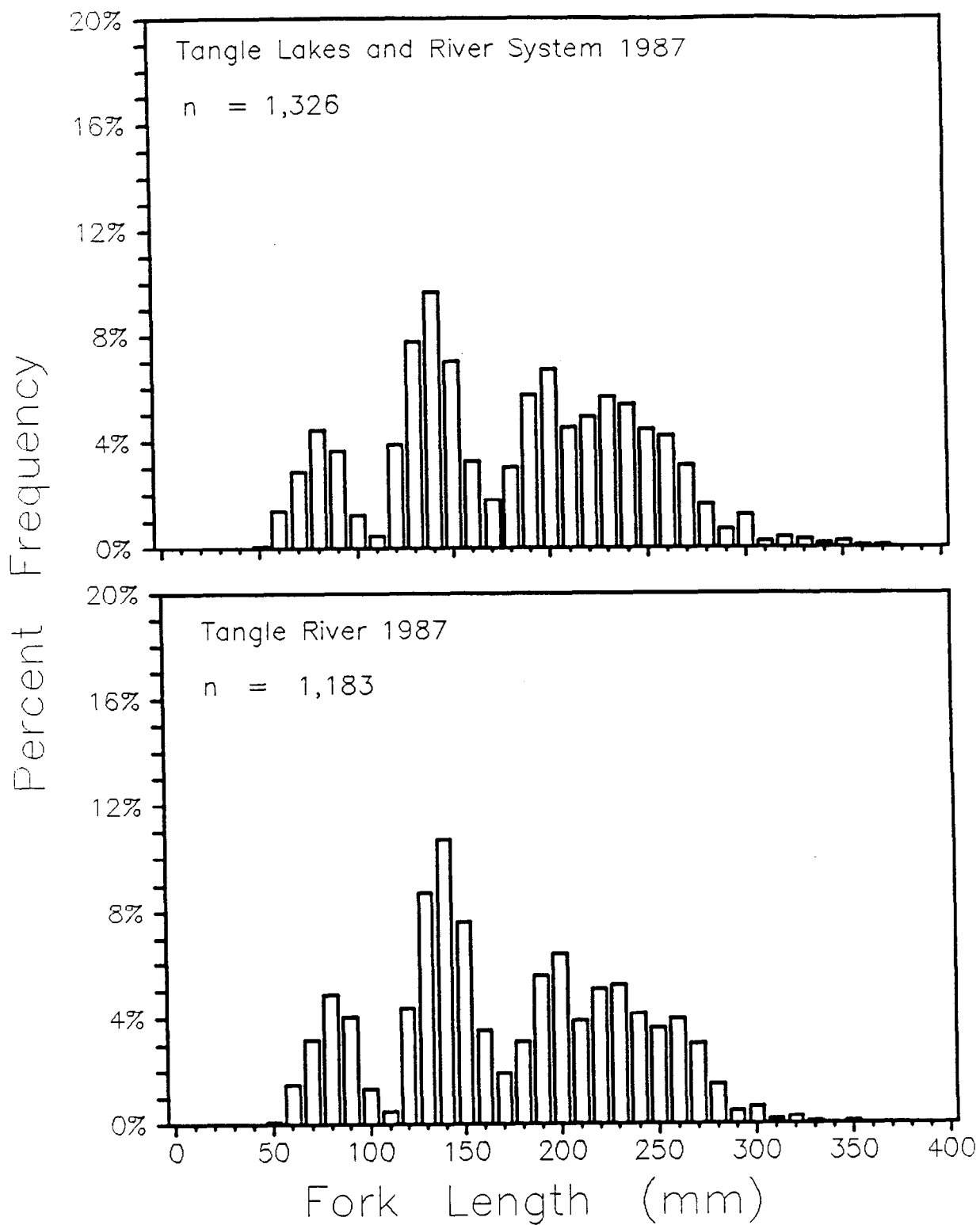


Figure 6. Comparison of length frequencies for Arctic grayling in the Tangle Lakes and River system and Tangle River, Alaska, 1987.

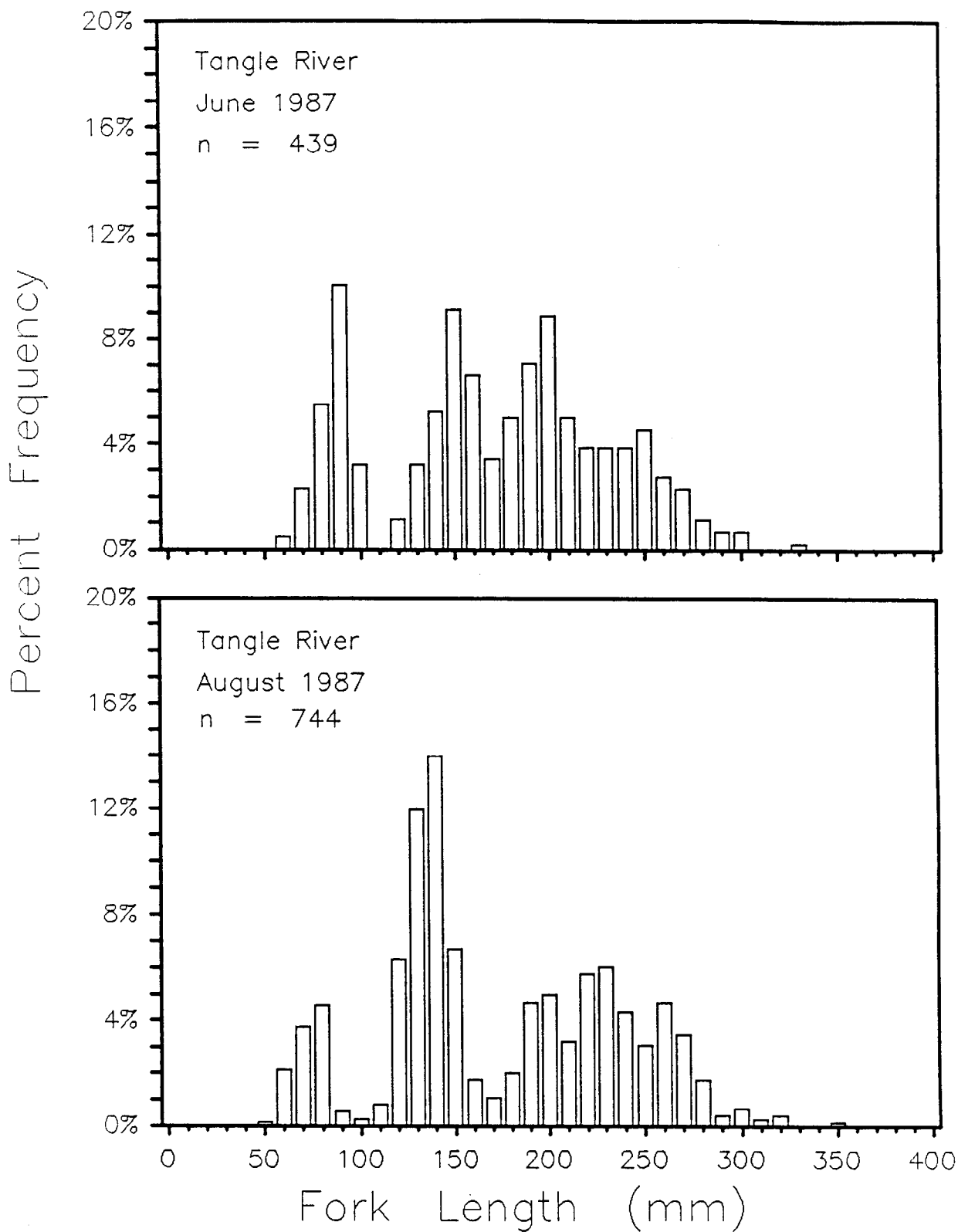


Figure 7. Comparison of length frequencies of Arctic grayling caught during June and August in the Tangle River, Alaska 1987.



Table 8. Estimates of Relative Stock Density (RSD) for Arctic grayling in the Tangle Lakes and River system, Alaska, June through August 1987.

Category		Tangle River Only											
		1987			Combined			June			August		
		n	%	SE	n	%	SE	n	%	SE	n	%	SE
Stock	150-269	751	87.6	1.1	641	89.5	1.1	281	92.7	1.5	360	87.2	1.6
Quality	270-339	99	11.6	1.1	74	10.3	1.1	22	7.3	1.5	52	12.6	1.6
Preferred	240-449	7	0.8	0.3	1	0.1	0.1	0	0.0	-	1	0.2	0.2
Memorable	450-559	0	0.0	-	0	0.0	-	0	0.0	-	0	0.0	-
Trophy	560-up	0	0.0	-	0	0.0	-	0	0.0	-	0	0.0	-
Total		857			716			303			413		

#### Age Composition:

The age of Arctic grayling captured in the Tangle System during 1987 ranged from 0 to 8 years (Table 9). Over 90% of Arctic grayling captured ranged from age 1 to age 4 with age 3 fish comprising the largest percentage (27.6%). A much larger number of younger Arctic grayling were found in the Tangle River during August than during June. Thirty-seven percent of the captured fish were age 1 in August while only 5% were age 1 in June.

#### Mean Fork Length-at-Age:

Mean fork length-at-age was determined for all age classes of Arctic grayling captured during 1987 (Table 10). Arctic grayling show steady growth up to age 6. Mean fork length-at-age was determined for the Tangle River. Mean fork length-at-age for fish caught during June and August indicate steady growth for ages 2 through 6. As an example age 2 fish averaged 156 mm in June and 199 mm in August.

#### 1988 Results

A total of 7,399 Arctic grayling were sampled throughout the Tangle System (Table 11). Sampling was most intensive during the months of June and August (Table 12). The largest number of Arctic grayling were captured by hook-and-line gear (Table 12).

#### Estimation of Mixing Rates:

The 400 tag recoveries needed to estimate mixing of Arctic grayling in the Tangle System were not obtained. Therefore, an estimate of mixing was not generated for 1988.

#### Length Frequencies:

Arctic grayling captured in the Tangle System during 1988 ranged in fork length from 50 mm up to 397 mm (Figure 8). The greatest percentage of Arctic grayling captured were over 250 mm. Comparison of length frequencies for all capture gears used in the Tangle System during 1988 show gill nets and hook-and-line gear caught the largest fish, and fyke nets the smallest fish (Figure 9). Both electrofishing and seine gear caught the widest range of sizes of Arctic grayling. Arctic grayling length frequencies in July and August were similar (Figure 10). Length frequencies of Arctic grayling captured in June and September differed from those Arctic grayling captured in July and August. This difference was probably due to the type of gear used in each month.

Arctic grayling captured downstream and upstream of the falls in the Delta River had almost identical size distributions (Figure 11). Arctic grayling captured in the lower sections of the Tangle System had dramatically different length distributions (Figure 12). The majority of Arctic grayling caught in Upper Tangle Lake were much larger than those caught in Round Tangle Lake (Figure 13). Arctic grayling captured in the Tangle River had a much wider length distribution than those caught in the Upper Tangle River (Figure 14).

Table 9. Estimates of the contributions of each age class of Arctic grayling in the Tangle Lakes and River system, Alaska, June through August 1987.

Age	Tangle River Only											
	1987			1987			June			August		
	n	%	SE	n	%	SE	n	%	SE	n	%	SE
0	54	5.5	0.7	54	6.4	0.8	0	0.0	-	54	9.6	1.2
1	226	22.9	1.3	225	26.6	1.5	15	5.2	1.3	210	37.4	2.0
2	155	15.7	1.2	151	17.8	1.3	57	19.9	2.4	94	16.8	1.6
3	273	27.6	1.4	229	27.0	1.5	120	42.0	2.9	109	19.4	1.7
4	209	21.2	1.3	149	17.6	1.3	68	23.8	2.5	81	14.4	1.5
5	50	5.1	0.7	34	4.0	0.7	23	8.0	1.6	11	2.0	0.6
6	15	1.5	0.4	5	0.6	0.3	3	1.0	0.6	2	0.4	0.3
7	4	0.4	0.2	0	0.0	-	0	0.0	-	0	0.0	-
8	2	0.2	0.1	0	0.0	-	0	0.0	-	0	0.0	-
All	988			847			286			561		

Table 10. Estimates of the mean fork length-at-age (mm) of Arctic grayling in the Tangle Lakes and River system, Alaska, June through August 1987.

Age	Tangle River Only											
	1987			Combined			June			August		
	n	Mean	SE	n	Mean	SE	n	Mean	SE	n	Mean	SE
0	54	79	1	54	79	1	0	-	-	54	79	1
1	226	136	1	225	136	1	15	136	5	210	140	1
2	156	182	2	151	183	2	57	156	1	94	199	1
3	273	214	1	229	215	1	120	201	2	109	231	1
4	209	253	1	149	255	2	68	243	2	81	264	2
5	50	281	3	34	281	3	23	275	3	11	293	4
6	14	318	5	5	317	10	3	302	3	2	340	12
7	4	349	9	0	-	-	0	-	-	0	-	-
8	2	343	3	0	-	-	0	-	-	0	-	-
Total	988			847			286			561		

Table 11. Location summary of the number of Arctic grayling caught, marked, and recaptured in the Tangle Lakes and River system, Alaska, during 1988.

Location	Location Code	Number Caught	Number Marked	Number Recaptured			
				1986	1987	1988	Total
Location Summary							
Delta River (DS of Falls)	060	1,775	1,727	0	1	15	16
Delta River (US of Falls)	075	805	757	0	3	22	25
Lower Tangle Lake	100	0	0	0	0	0	0
Lower End	101	31	24	0	0	0	0
Upper End	150	5	4	0	0	0	0
Thoroughfare (Lower and Long)	175	228	187	1	1	6	8
Long Tangle Lake	200	229	8	0	0	0	0
Lower End	201	19	4	0	0	0	0
Thoroughfare (Middle of Lake)	225	0	0	0	0	0	0
Upper End	250	9	7	0	0	0	0
Thoroughfare (Long and Shallow)	275	8	7	0	0	0	0
Shallow Tangle Lake	300	76	12	0	1	0	1
Lower End	301	89	53	0	1	4	5
Creek East of Thoroughfare	305	0	0	0	0	0	0
Upper End	325	0	0	0	0	0	0
Thoroughfare (Shallow and Round)	350	100	79	1	2	5	8
Landmark Gap Creek	360	3	0	1	0	2	3
Lower Section	361	167	119	0	1	2	3
Middle Section	365	125	114	0	1	1	2
Upper Section	367	26	26	0	0	0	0
Landmark Gap Lake	370	0	0	0	0	0	0
Lower End	371	13	8	0	1	2	3
Upper End	375	0	0	0	0	0	0
Clear Creek	380	0	0	0	0	0	0
Downstream of 18 Mile Creek	381	0	0	0	0	0	0
Upstream of 18 Mile Creek	385	98	14	0	0	0	0
18 Mile Creek	390	0	0	0	0	0	0
Downstream of Denali Hghwy	391	226	63	0	3	1	4
Upstream of Denali Hghwy	395	0	0	0	0	0	0
Round Tangle Lake	400	604	23	0	2	4	6
Lower End (North Shore)	401	3	1	0	0	0	0
Upper End (South Shore)	450	6	2	0	0	0	0
Round Tangle Lake (Near Mouth)	490	45	34	0	1	6	7
Tangle River	500	47	0	1	3	7	11
Downstream of Denali Hghwy	501	855	177	0	9	2	11
Upstream of Denali Hghwy	502	264	91	0	0	1	1
Upper Tangle Lake	600	244	129	1	4	0	5
Lower End	601	105	14	0	0	1	1
Near Mouth of Rock Creek	605	426	278	0	7	28	35
Rock Creek	610	3	0	0	0	3	3
DS of Denali Hghwy	625	67	49	0	1	4	5
US of Denali Hghwy to Glacier L Cr	630	268	203	0	0	6	6
US of Glacier Lake Creek	640	2	0	0	0	0	0
Upper End	690	9	1	0	0	0	0
Near Mouth of Upper Tangle River	695	0	0	0	0	0	0
Upper Tangle River	700	30	18	0	0	0	0
Lower Section Upper Tangle River	710	329	150	0	1	4	5
Middle Section	750	0	0	0	0	0	0
Upper Section	790	58	36	0	0	0	0
Landlocked Tangle Lake	800	0	0	0	0	0	0
Mud Lake	900	0	0	0	0	0	0
Misc Upper Tangle Lakes (Unnamed)	950	0	0	0	0	0	0
Unknown	-	2	0	0	1	1	2
Total	-	7,399	4,419	5	44	127	176

Table 12. Date and gear summary of the number of Arctic grayling caught, marked, and recaptured in the Tangle Lakes and River system, Alaska, during 1988.

Location	Location Code	Number Caught	Number Marked	Number Recaptured			
				1986	1987	1988	Total
Date Summary							
June	-	2,041	613	2	16	36	54
July	-	1,732	1,173	1	14	24	39
August	-	2,520	2,087	2	8	44	54
September	-	1,101	544	0	6	23	29
Unknown	-	1	0	0	0	0	0
Total	-	7,395	4,417	5	44	127	176
Sampling Gear Summary							
Gill Net	-	231	129	1	3	0	4
Electrofishing	-	946	705	0	4	12	16
Seine	-	1,625	719	0	15	33	48
Fyke Net	-	1,292	99	0	2	1	3
Hook and Line	-	3,301	2,765	4	20	81	105
Total	-	7,395	4,417	5	44	127	176

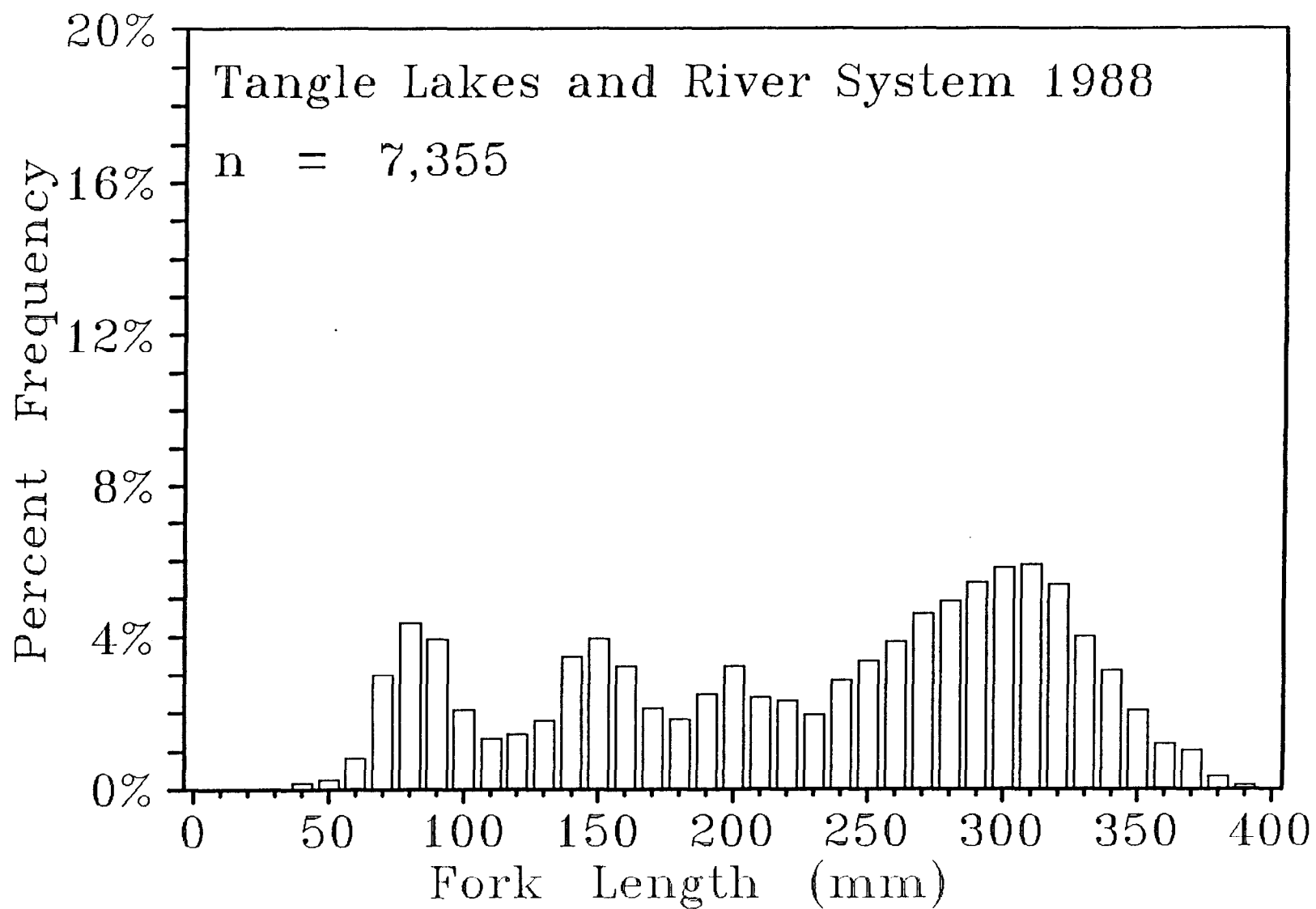


Figure 8. Length frequency of Arctic grayling in the Tangle Lakes and River system, Alaska, 1988

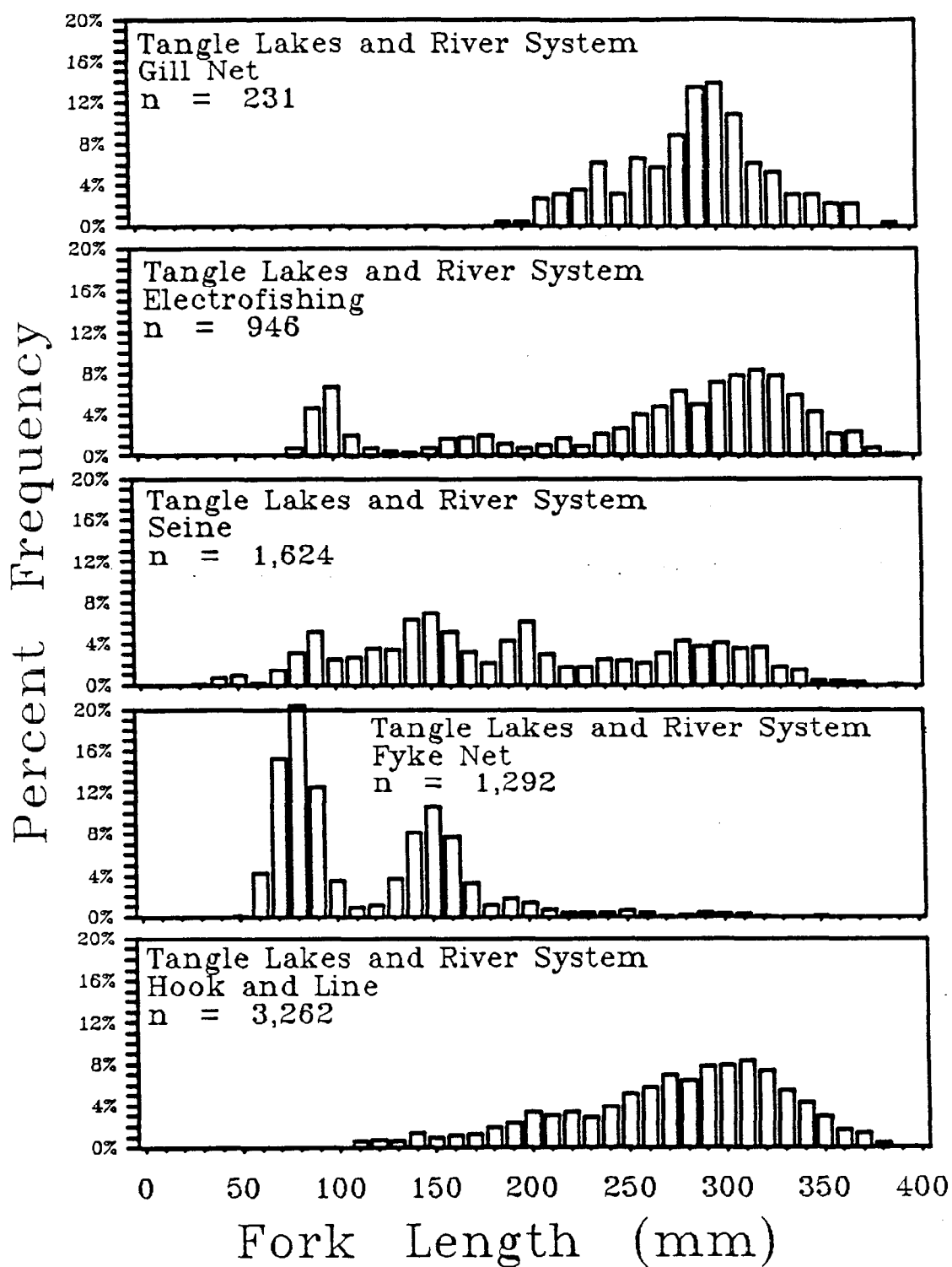


Figure 9. Comparison of length frequencies of Arctic grayling caught by various gear types in the Tangle Lakes and River system, Alaska, 1988.



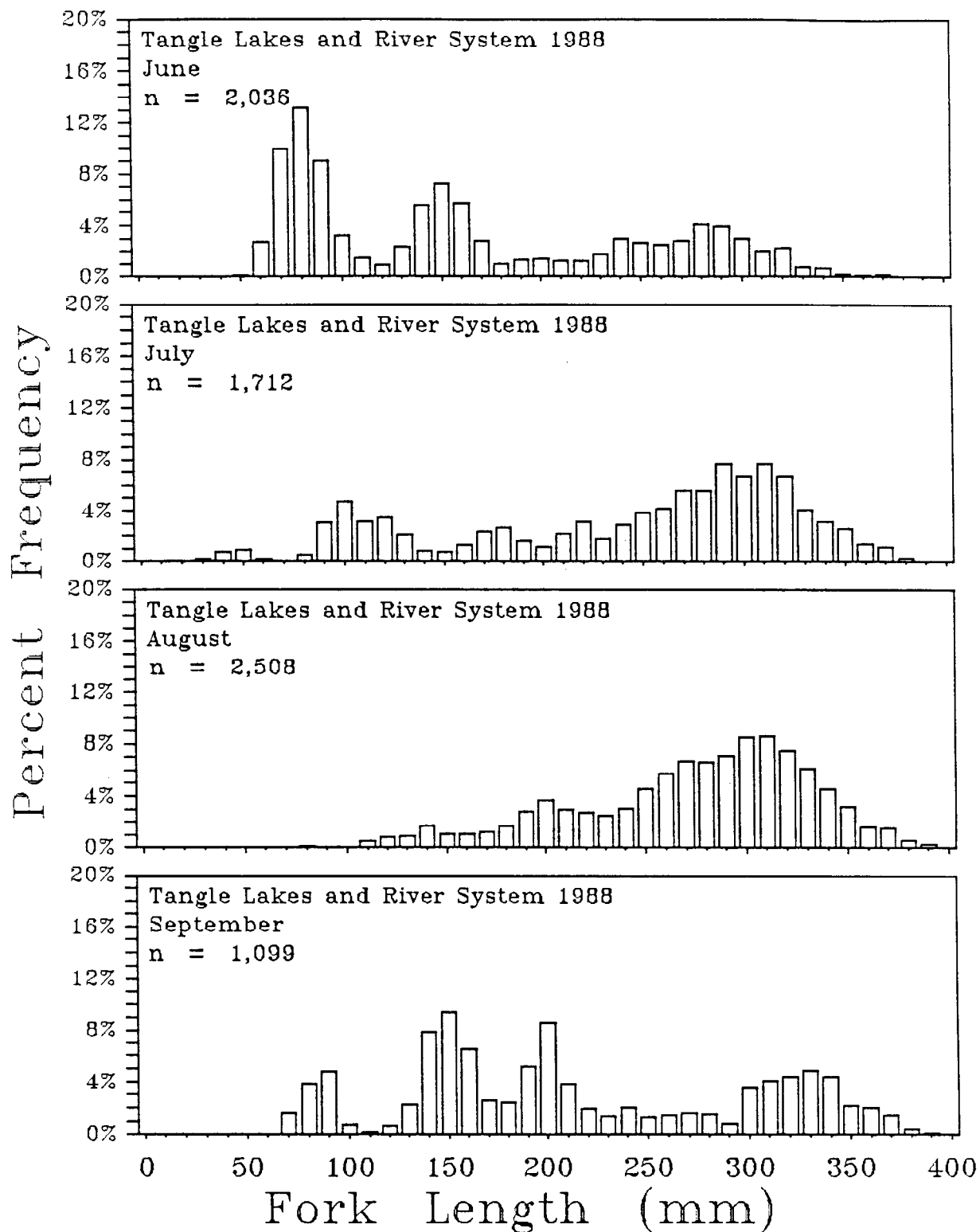


Figure 10. Comparison of length frequencies of Arctic grayling caught during June, July, August, and September in the Tangle Lakes and River system, Alaska, 1988.

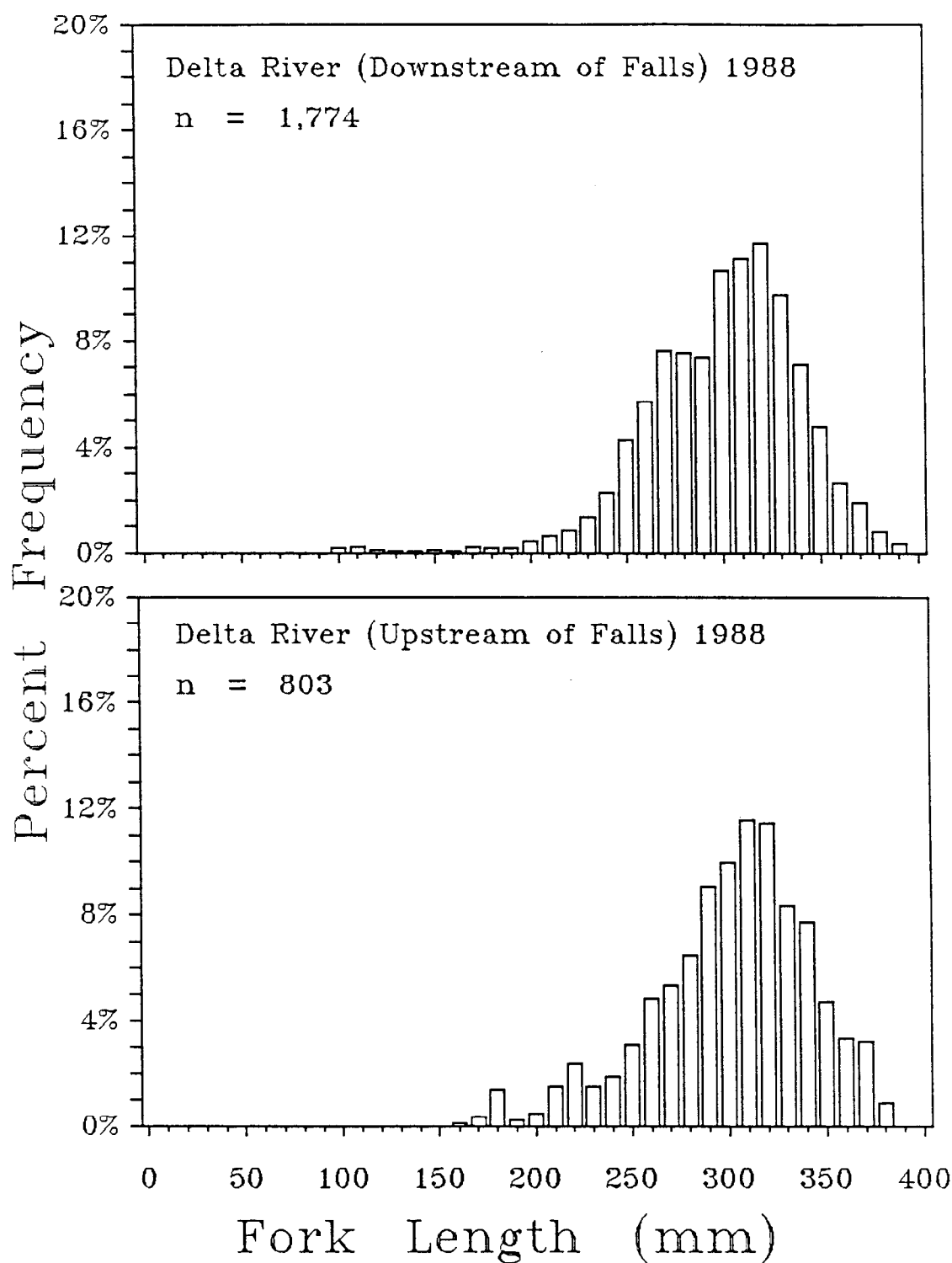


Figure 11. Comparison of length frequencies of Arctic grayling caught downstream and upstream of the falls in the Delta River, Alaska, 1988.

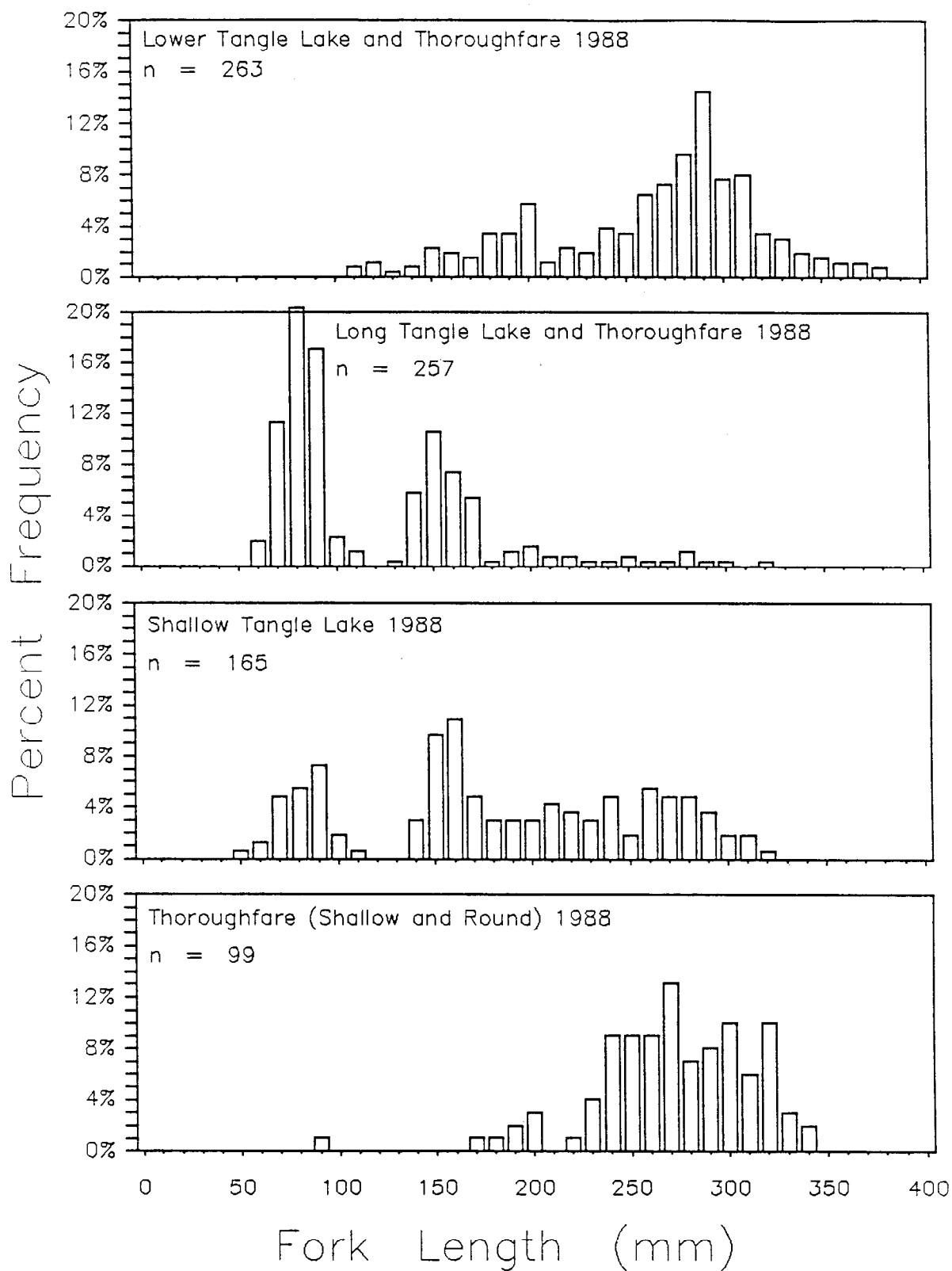


Figure 12. Comparison of length frequencies of Arctic grayling caught in the lower sections of the Tangle Lakes and River system, Alaska, 1988.

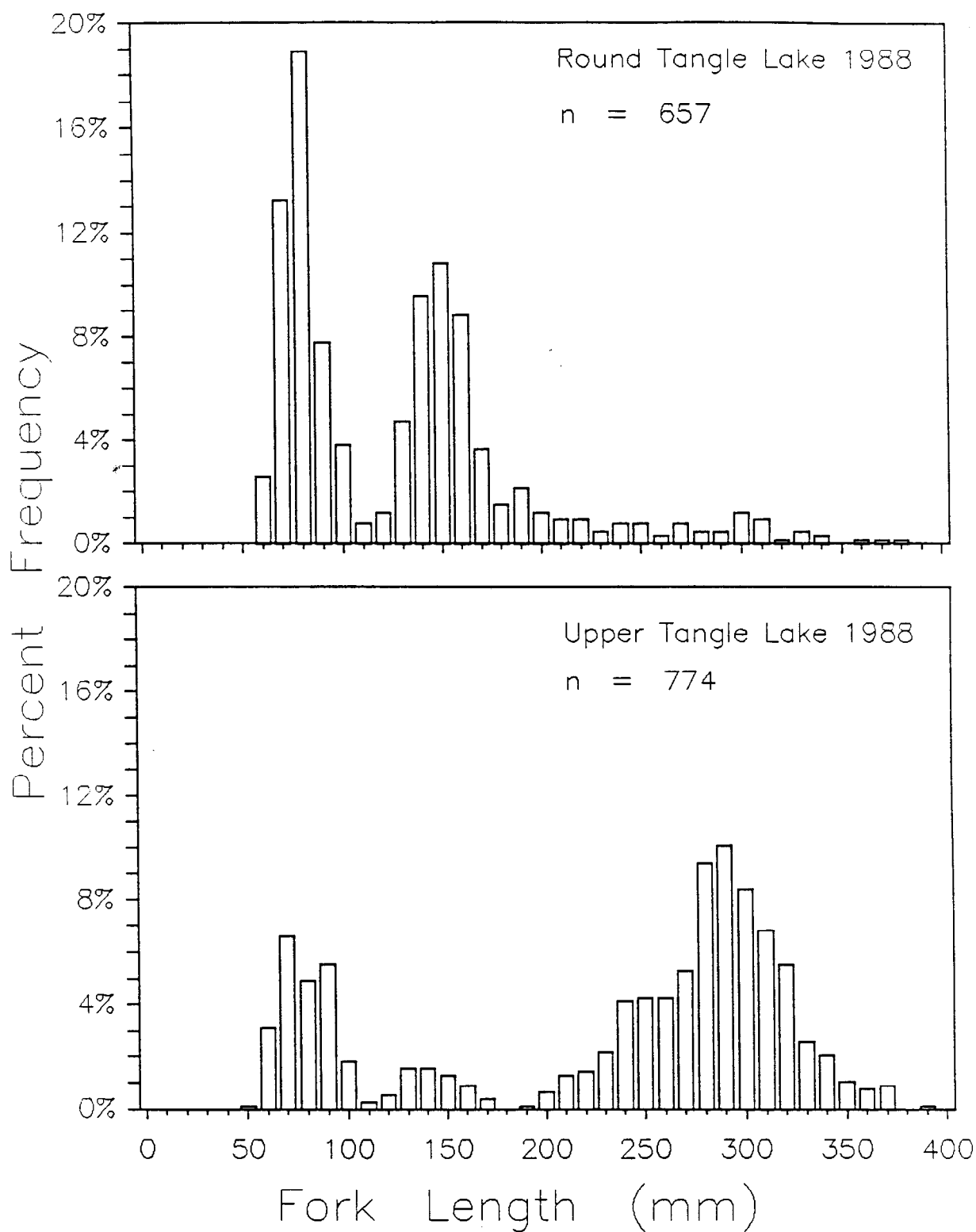


Figure 13. Comparison of length frequencies of Arctic grayling in Round and Upper Tangle lakes, Alaska, 1988.

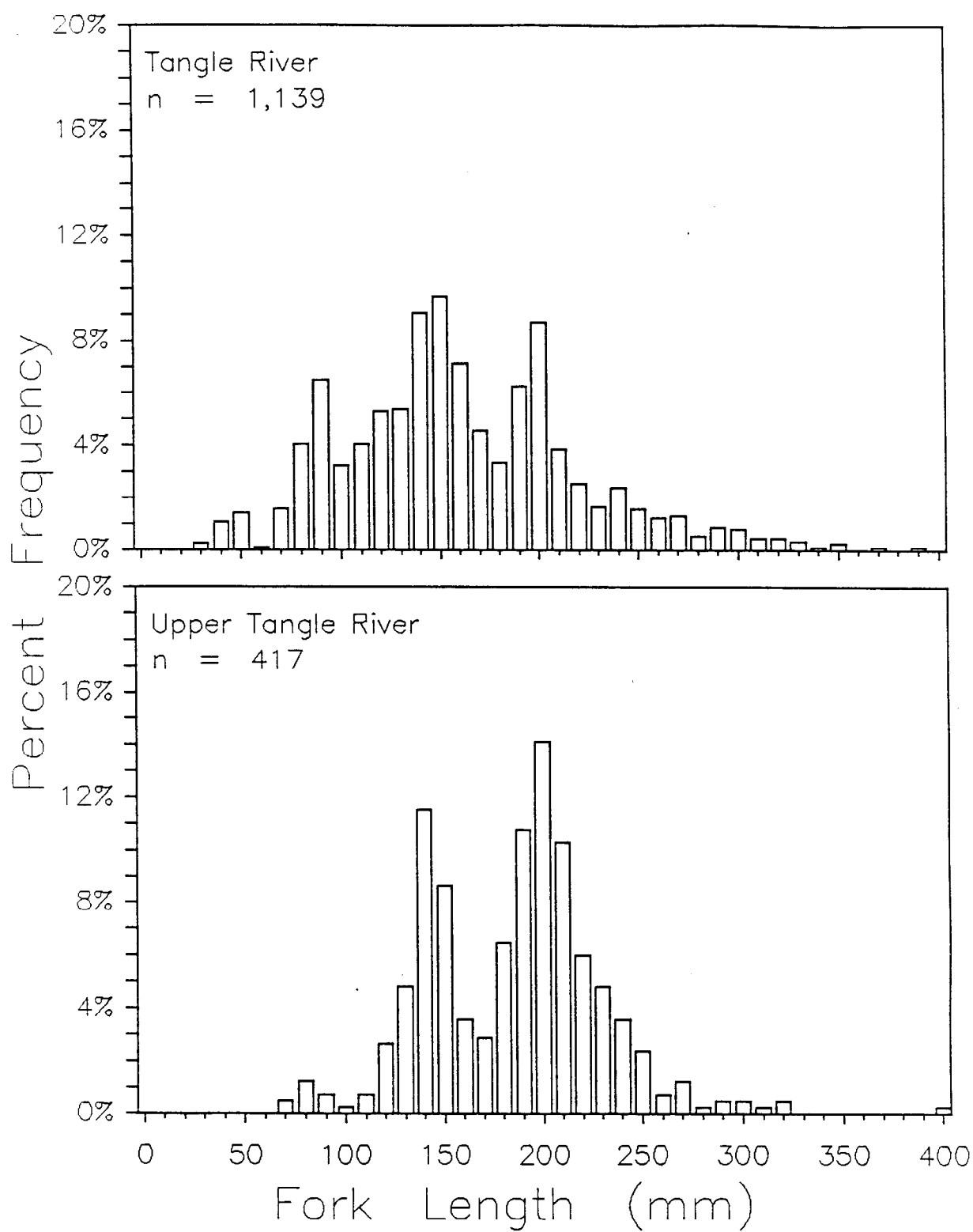


Figure 14. Comparison of length frequencies of Arctic grayling in the Tangle River and Upper Tangle River, Alaska, 1988.

Arctic grayling captured in Clear and 18 Mile Creeks were much smaller than those fish caught in Landmark Gap and Rock Creeks (Figure 15). The majority of the differences between all the areas were probably due to the type of capture gear used.

#### Relative Stock Density:

Arctic grayling over 150 mm in fork length were almost evenly split between stock size (43.3%) and quality size (46.6%) with 10.1% in the preferred size range (Table 13). No Arctic grayling captured were of memorable or trophy size. Relative Stock Densities by month of capture were similar for the months of June and September, and for July and August. The majority of Arctic grayling over 150 mm that were captured in June and September were of stock size while the majority of the fish captured in July and August were of quality size. Relative Stock Densities for the Delta River upstream and downstream of the falls were similar (Table 14). There was a greater number of larger Arctic grayling in the thoroughfare between Lower and Long Tangle Lakes than in Long Tangle Lake. Relative Stock Densities for the middle sections of the Tangle System were quite varied (Table 15). Landmark Gap Creek had the greatest percentage of quality size Arctic grayling. In comparing the RSD's for the upper sections of the Tangle System, the Tangle River and Upper Tangle River had similar RSD's with over 90% of the Arctic grayling over 150 mm being stock size (Table 16). In contrast, Arctic grayling captured in Upper Tangle Lake were composed mostly of quality size fish.

#### Age Composition:

Arctic grayling captured in the Tangle System during 1988 ranged in age from 0 to 9 years (Table 17). The largest percentage of captured fish were either age 5 (17.2%) or age 6 (18.7%). Age 0 to age 4 Arctic grayling each comprised approximately 10% of the captured Arctic grayling. Age composition differed by month and was probably reflective of the various sampling gears used. Age compositions for Arctic grayling captured upstream and downstream of the falls in the Delta River were almost identical (Table 18). Over 80% of Arctic grayling captured in the Delta River were age 5, 6, or 7 with approximately 35% to 38% age 6. Age compositions were also determined for the lower (Table 18), middle (Table 19), and upper (Table 20) sections of the Tangle System. Age compositions were found to be highly variable between areas.

#### Mean Fork Length-at-Age:

Mean fork length-at-age was determined for all age classes of Arctic grayling captured during 1988 (Table 21). Arctic grayling showed steady growth throughout their entire life span. Comparison of mean fork length-at-age by month of capture indicates that Arctic grayling put on a large proportion of their growth during the summer (Table 21). Mean fork length-at-age measurements were similar for Arctic grayling throughout the entire Tangle System (Tables 22-24).

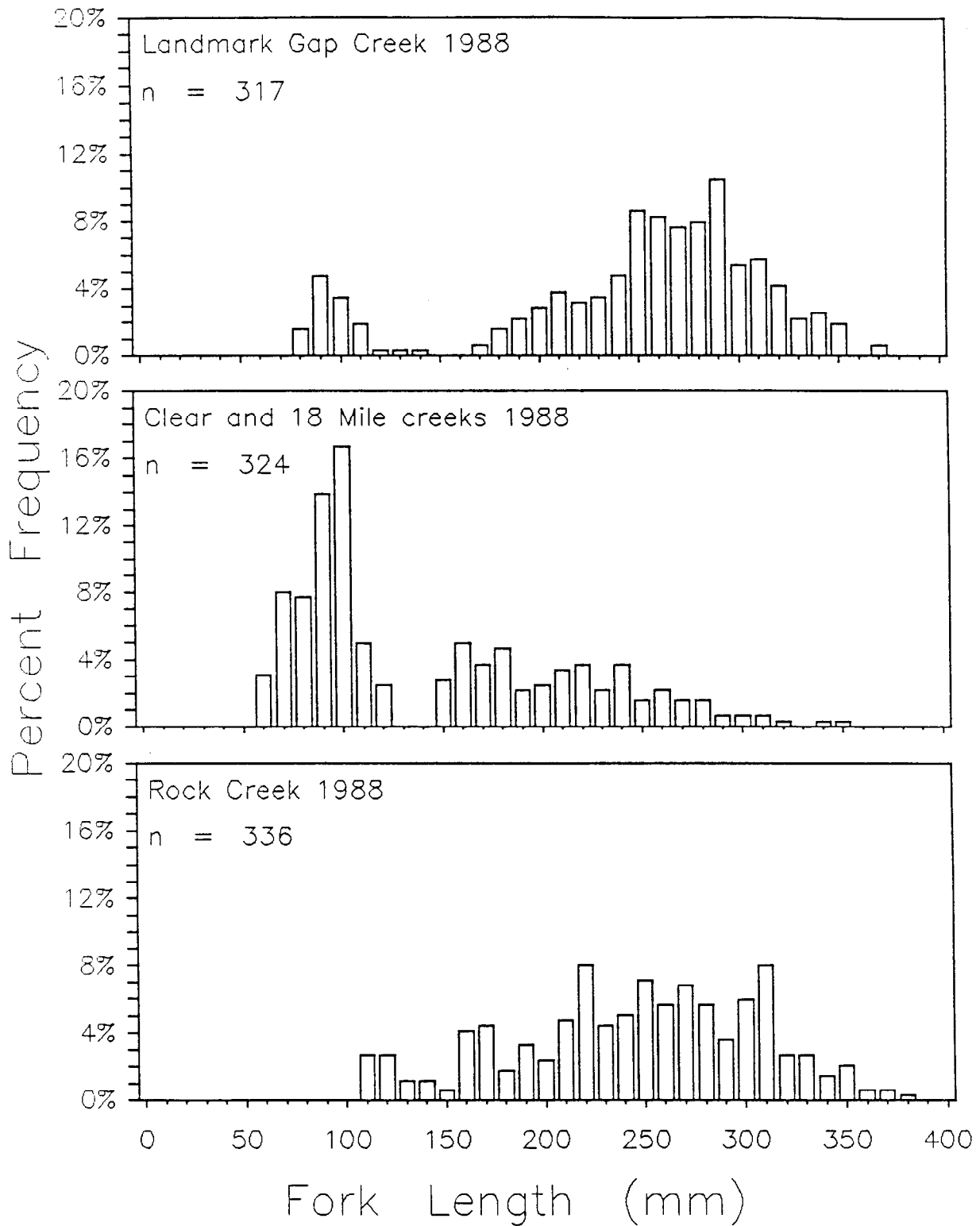


Figure 15. Comparison of length frequencies of Arctic grayling in Landmark Gap Creek, Clear and 18 Mile Creeks, and Rock Creek, Alaska, 1988.

Table 13. Estimates of Relative Stock Density (RSD) by date for Arctic grayling in the Tangle Lakes and River system, Alaska, 1988.

Category	Fork Length Range (mm)	1988			June			July			August			September		
		n	%	SE	n	%	SE	n	%	SE	n	%	SE	n	%	SE
Stock	150-269	2,462	43.3	0.7	644	61.4	1.5	477	34.7	1.3	830	34.5	1.0	511	59.6	1.7
Quality	270-339	2,647	46.6	0.7	381	36.3	1.5	752	54.7	1.3	1,284	53.4	1.0	230	26.8	1.5
Preferred	240-449	577	10.1	0.4	24	2.3	0.5	145	10.6	0.8	292	12.1	0.7	116	13.5	1.2
Memorable	450-559	0	0.0	-	0	0.0	-	0	0.0	-	0	0.0	-	0	0.0	-
Trophy	560-up	0	0.0	-	0	0.0	-	0	0.0	-	0	0.0	-	0	0.0	-
Total		5,686			1,049			1,374			2,406			857		



Table 14. Estimates of Relative Stock Density (RSD) by location for Arctic grayling in the Delta River and lower sections of the Tangle Lakes and River system, Alaska, 1988.

Category	Fork Length Range (mm)	Delta River (DS of Falls)			Delta River (US of Falls)			Thoroughfare (Lower and Long)			Long Tangle Lake (200-275)		
		n	%	SE	n	%	SE	n	%	SE	n	%	SE
Stock	150-269	288	16.3	0.9	143	17.8	1.4	98	38.4	3.1	83	90.2	3.1
Quality	270-339	1,163	66.0	1.1	500	62.3	1.7	140	54.9	3.1	9	9.8	3.1
Preferred	240-449	312	17.7	0.9	160	19.9	1.4	17	6.7	1.6	0	0.0	0.0
Memorable	450-559	0	0.0	-	0	0.0	-	0	0.0	-	0	0.0	-
Trophy	560-up	0	0.0	-	0	0.0	-	0	0.0	-	0	0.0	-
Total		1,763			803			255			92		

Table 15. Estimates of Relative Stock Density (RSD) by location for Arctic grayling in the middle sections of the Tangle Lakes and River system, Alaska, 1988.

Category	Fork Length Range (mm)	Shallow Tangle Lake (300-350)			Landmark Gap Creek (360-375)			Clear Creek (380-395)			Round Tangle Lake (400-490)		
		n	%	SE	n	%	SE	n	%	SE	n	%	SE
Stock	150-269	134	60.4	3.3	128	44.1	2.9	121	86.4	2.9	212	86.2	2.2
Quality	270-339	86	38.7	3.3	144	49.7	2.9	17	12.1	2.8	29	11.8	2.1
Preferred	240-449	2	0.9	0.6	18	6.2	1.4	2	1.4	1.0	5	2.0	0.9
Memorable	450-559	0	0.0	-	0	0.0	-	0	0.0	-	0	0.0	-
Trophy	560-up	0	0.0	-	0	0.0	-	0	0.0	-	0	0.0	-
Total		222			290			140			246		

Table 16. Estimates of Relative Stock Density (RSD) by location for Arctic grayling in the upper sections of the Tangle Lakes and River system, Alaska, 1988.

Category	Fork Length Range (mm)	Tangle River (500-502)			Upper Tangle Lake (600-605)			Rock Creek (610-640)			Upper Tangle River (700-790)		
		n	%	SE	n	%	SE	n	%	SE	n	%	SE
Stock	150-269	602	90.9	1.1	162	28.3	1.9	174	56.1	2.8	317	96.1	1.1
Quality	270-339	54	8.2	1.1	373	65.1	2.0	119	38.4	2.8	13	3.9	1.1
Preferred	240-449	6	0.9	0.4	38	6.6	1.0	17	5.5	1.3	0	0.0	0.0
Memorable	450-559	0	0.0	-	0	0.0	-	0	0.0	-	0	0.0	-
Trophy	560-up	0	0.0	-	0	0.0	-	0	0.0	-	0	0.0	-
Total		662			573			310			330		

Table 17. Monthly estimates of the contributions of each age class of Arctic grayling in the Tangle Lakes and River system, 1988.

Age	1988			June			July			August			September		
	n	%	SE	n	%	SE	n	%	SE	n	%	SE	n	%	SE
0	836	15.2	0.4	587	38.5	0.6	146	11.4	0.4	11	0.6	0.1	92	11.2	0.4
1	487	9.0	0.3	122	8.0	0.3	109	8.5	0.3	81	4.3	0.2	185	22.5	0.5
2	504	9.2	0.3	270	17.7	0.4	70	5.5	0.3	75	4.0	0.2	89	10.8	0.4
3	597	10.8	0.4	80	5.2	0.3	116	9.0	0.3	247	13.1	0.4	155	18.8	0.5
4	473	8.6	0.3	108	7.1	0.3	113	8.8	0.3	212	11.2	0.4	41	4.9	0.3
5	950	17.2	0.4	170	11.1	0.4	257	20.0	0.5	472	25.1	0.5	49	6.0	0.3
6	1,030	18.7	0.5	140	9.2	0.3	292	22.7	0.5	479	25.4	0.5	120	14.6	0.4
7	489	8.9	0.3	43	2.8	0.2	139	10.8	0.4	234	12.4	0.4	73	8.8	0.3
8	134	2.4	0.2	7	0.4	0.1	40	3.2	0.2	68	3.6	0.2	19	2.3	0.2
9	5	0.1	0.0	0	0.0	-	2	0.1	0.0	3	0.2	0.0	1	0.1	0.0
Total	5,505			1,527			1,284			1,882			824		

Table 18. Estimates of the contributions of each age class, by location, of Arctic grayling in the Tangle Lakes and River system, 1988.

Age	Delta River (DS of Falls)			Delta River (US of Falls)			Thoroughfare (Lower and Long)			Long Tangle Lake (200-275)		
	n	%	SE	n	%	SE	n	%	SE	n	%	SE
0	2	0.2	0.1	0	0.0	-	2	0.8	0.2	116	58.5	1.2
1	4	0.4	0.1	0	0.0	-	8	3.8	0.5	7	3.4	0.4
2	5	0.5	0.2	7	0.9	0.2	12	6.1	0.6	52	26.4	1.0
3	25	2.3	0.4	31	5.1	0.5	28	14.1	0.8	8	4.5	0.5
4	97	9.1	0.7	41	6.8	0.6	18	9.1	0.7	6	3.0	0.4
5	281	26.4	1.0	149	24.7	1.0	66	33.5	1.1	5	2.6	0.4
6	371	34.8	1.1	231	38.4	1.2	46	23.6	1.0	2	0.8	0.2
7	219	20.6	1.0	110	18.3	0.9	11	5.7	0.6	2	0.8	0.2
8	58	5.4	0.5	35	5.7	0.6	7	3.4	0.4	0	0.0	-
9	2	0.2	0.1	1	0.1	0.0	0	0.0	-	0	0.0	-
Total	1,064			605			198			198		

Table 19. Estimates of the contributions of each age class, by location, of Arctic grayling in the middle sections of the Tangle Lakes and River system, 1988.

Age	Shallow Tangle Lake (300-350)			Landmark Gap Creek (360-375)			Clear Creek (380-395)			Round Tangle Lake (400-490)		
	n	%	SE	n	%	SE	n	%	SE	n	%	SE
0	27	13.6	2.1	25	10.0	1.8	128	52.5	3.1	229	46.4	3.1
1	2	1.1	0.7	5	2.1	0.9	10	4.3	1.3	66	13.4	2.1
2	34	17.0	2.3	5	2.1	0.9	36	14.8	2.2	128	26.0	2.7
3	25	12.5	2.0	30	12.1	2.0	30	12.3	2.0	29	5.9	1.5
4	27	13.6	2.1	49	19.7	2.5	19	7.7	1.6	12	2.4	1.0
5	50	25.0	2.7	77	31.2	2.9	14	5.6	1.4	11	2.1	0.9
6	26	12.9	2.1	38	15.5	2.2	5	2.2	0.9	12	2.4	1.0
7	8	4.2	1.2	16	6.1	1.5	1	0.3	0.3	4	0.8	0.5
8	0	0.0	-	3	1.2	0.7	1	0.3	0.3	2	0.5	0.4
9	0	0.0	-	0	0.0	-	0	0.0	-	0	0.0	-
Total	199			248			244			493		

Table 20. Estimates of the contributions of each age class, by location, of Arctic grayling in the upper sections of Tangle Lakes and River system, 1988.

Age	Tangle River (500-502)			Upper Tangle Lake (600-605)			Rock Creek (610-640)			Upper Tangle River (700-790)		
	n	%	SE	n	%	SE	n	%	SE	n	%	SE
0	161	18.9	1.2	130	22.4	1.2	7	2.7	0.5	10	3.3	0.5
1	294	34.4	1.4	19	3.2	0.5	14	5.7	0.7	67	20.9	1.2
2	122	14.2	1.0	17	3.0	0.5	26	10.1	0.9	62	19.3	1.2
3	180	21.1	1.2	14	2.5	0.5	51	20.2	1.2	139	43.5	1.5
4	50	5.8	0.7	58	10.1	0.9	42	16.7	1.1	30	9.4	0.9
5	26	3.0	0.5	141	24.3	1.3	53	21.1	1.2	8	2.4	0.4
6	16	1.8	0.4	143	24.7	1.3	44	17.3	1.1	4	1.2	0.3
7	5	0.6	0.2	47	8.1	0.8	12	4.8	0.6	0	0.0	-
8	1	0.1	0.1	10	1.7	0.4	4	1.5	0.4	0	0.0	-
9	1	0.1	0.1	1	0.1	0.1	0	0.0	-	0	0.0	-
Total	856			580			253			320		

Table 21. Monthly estimates of mean fork length-at-age (mm) of Arctic grayling in the Tangle Lakes and River system, Alaska, 1988.

Age	1988			June			July			August			September		
	n	Mean	SE	n	Mean	SE	n	Mean	SE	n	Mean	SE	n	Mean	SE
0	836	84	0.6	587	84	0.5	146	89	1.8	11	82	12.9	92	89	0.8
1	487	139	0.5	122	134	0.8	109	127	0.8	818	140	1.0	185	149	0.5
2	504	166	0.4	270	160	0.4	70	172	0.9	75	175	0.9	89	176	1.0
3	597	208	0.4	80	201	1.2	116	207	1.1	247	210	0.7	155	208	0.7
4	473	247	0.4	108	241	0.7	113	245	0.7	212	250	0.5	41	251	1.2
5	950	280	0.3	170	274	0.7	257	279	0.6	472	282	0.4	49	287	1.5
6	1,030	313	0.3	140	304	0.7	292	311	0.4	479	315	0.4	120	322	0.7
7	489	342	0.4	43	332	1.1	139	340	0.6	234	344	0.4	73	349	0.8
8	134	371	0.6	7	368	3.1	40	368	1.1	68	372	0.8	19	374	1.1
9	5	393	1.2	0	-	-	2	392	3.0	3	392	1.4	1	397	-
Total	5,505			1,527			1,284			1,882			824		



Table 22. Estimates of mean fork length-at-age (mm) of Arctic grayling in the Delta River and the lower sections of the Tangle Lakes and River system, Alaska, 1988.

Age	Delta River (DS of Falls)			Delta River (US of Falls)			Thoroughfare (Lower and Long)			Long Tangle Lake (200-275)		
	n	Mean	SE	n	Mean	SE	n	Mean	SE	n	Mean	SE
0	2	108	1.3	0	-	-	2	74	52.3	116	86	0.7
1	4	125	3.4	0	-	-	8	142	3.6	7	137	4.1
2	5	169	4.1	5	176	2.6	12	172	2.8	52	160	1.1
3	25	215	2.0	31	211	2.3	28	203	2.0	8	204	3.1
4	97	251	0.7	41	246	1.3	18	245	1.7	6	246	4.1
5	281	281	0.5	149	282	0.9	66	281	1.2	5	275	4.4
6	371	315	0.4	231	316	0.6	46	310	1.3	2	301	3.0
7	219	342	0.4	110	345	0.8	11	341	1.9	2	330	5.0
8	58	371	0.9	35	371	1.0	7	372	3.0	0	-	-
9	2	394	1.6	1	389	-	0	-	-	0	-	-
Total	1,064			603			198			198		

Table 23. Estimates of mean fork length-at-age (mm) of Arctic grayling in the middle sections of the Tangle Lakes and River system, Alaska, 1988.

Age	Shallow Tangle Lake (300-350)			Landmark Gap Creek (360-375)			Clear Creek (380-395)			Round Tangle Lake (400-490)		
	n	Mean	SE	n	Mean	SE	n	Mean	SE	n	Mean	SE
0	27	86	2.0	25	91	4.2	128	92	1.0	229	84	0.6
1	2	133	11.2	5	123	4.4	10	120	1.1	66	138	0.8
2	34	162	1.2	5	179	2.0	36	169	1.3	128	160	0.6
3	25	202	2.5	30	212	1.9	30	208	2.0	29	197	1.8
4	27	243	1.5	49	250	1.1	19	241	1.6	12	239	2.9
5	50	274	1.3	77	282	1.1	14	272	2.1	11	275	3.1
6	26	308	1.6	38	314	1.1	5	307	3.6	12	308	1.6
7	8	330	2.1	16	344	1.7	1	343	-	4	339	3.1
8	0	-	-	3	366	2.7	1	358	-	2	374	7.1
9	0	-	-	0	-	-	0	-	-	0	-	-
Total	199			248			244			493		

Table 24. Estimates of mean fork length-at-age (mm) of Arctic grayling in the upper sections of the Tangle Lakes and River system, Alaska, 1988.

Age	Tangle River (500-502)			Upper Tangle Lake (600-605)			Rock Creek (610-640)			Upper Tangle River (700-790)		
	n	Mean	SE	n	Mean	SE	n	Mean	SE	n	Mean	SE
0	161	84	1.6	130	82	1.1	7	104	12.2	10	91	3.7
1	294	141	0.7	19	135	1.3	14	134	2.5	67	141	1.0
2	122	175	0.8	17	158	1.8	26	172	1.3	62	168	1.5
3	180	207	0.7	14	212	2.0	51	215	1.5	139	208	0.8
4	50	249	1.2	58	242	1.0	42	248	1.0	30	244	1.3
5	26	280	1.8	141	278	0.8	53	280	1.3	8	278	3.3
6	16	312	2.1	143	307	0.7	44	314	1.2	4	316	4.3
7	5	344	3.2	47	336	1.4	12	346	2.1	0	-	-
8	1	375	-	10	370	1.8	4	373	3.7	0	-	-
9	1	395	-	1	390	-	0	-	-	0	-	-
Total	856			580			253			320		

#### ACKNOWLEDGEMENTS

My appreciation and thanks go to John H. Clark, Robert A. Clark, and Rolland A. Holmes for their support and assistance with this project. I also thank Joseph Klein, Kevin Secor, and Craig Monaco for their help with the extensive field work conducted in the Tangle Lakes. Appreciation is also given to all the Sport Fish personnel (too many to mention) that assisted with this project during the course of the summer.

#### LITERATURE CITED

- Baker, T. T. In press. Creel censuses in interior Alaska in 1987. Alaska Department of Fish and Game, Division of Sport Fish, Fishery Data Series.
- Carlton, M. 1976. Delta River - Tangle Lakes fisheries inventory. Bureau of Land Management, Anchorage, Alaska.
- Clark, R. A. and, W. P. Ridder. 1987. Abundance and length composition of selected grayling stocks in the Tanana drainage during 1986. Alaska Department of Fish and Game, Division of Sport Fish, Fishery Data Series No. 26. 55 pp.
- Gabelhouse, D. W. 1984. A length-categorization system to assess fish stocks. North American Journal of Fisheries Management 4:273-285.
- Heckart, L. 1965. Inventory and cataloging of the sport fish and sport fish waters in the interior of Alaska. Alaska Department of Fish and Game. Federal Aid in Fish Restoration, Annual Report of Progress, 1964-1965, Project F-5-R-6, 6 (15-A):291-305.
- Holmes, R. A., W. P. Ridder, and R. A. Clark. 1986. Distribution, abundance, and natural history of the Arctic grayling in the Tanana drainage. Alaska Department of Fish and Game. Federal Aid in Fish Restoration, Annual Report of Progress, 1985-1986, Project F-10-1, 27 (G-8-1). 68 pp.
- Mills, M. J. 1979. Alaska statewide sport fish harvest studies. Alaska Department of Fish and Game. Federal Aid in Fish Restoration, Annual Performance Report, 1978-1979, Project F-9-11, 20 (SW-I-A). 112 pp.
- \_\_\_\_\_. 1980. Alaska statewide sport fish harvest studies. Alaska Department of Fish and Game. Federal Aid in Fish Restoration, Annual Performance Report, 1979-1980, Project F-9-12, 21 (SW-I-A). 65 pp.
- \_\_\_\_\_. 1981a. Alaska statewide sport fish harvest studies (1979). Alaska Department of Fish and Game. Federal Aid in Fish Restoration, Annual Performance Report, 1980-1981, Project F-9-13, 22 (SW-I-A). 77 pp.

#### LITERATURE CITED (Continued)

- \_\_\_\_\_. 1981b. Alaska statewide sport fish harvest studies (1980). Alaska Department of Fish and Game. Federal Aid in Fish Restoration, Annual Performance Report, 1980-1981, Project F-9-13, 22 (SW-I-A). 107 pp.
- \_\_\_\_\_. 1982. Alaska statewide sport fish harvest studies (1981). Alaska Department of Fish and Game. Federal Aid in Fish Restoration, Annual Performance Report, 1981-1982, Project F-9-14, 23 (SW-I-A). 115 pp.
- \_\_\_\_\_. 1983. Alaska statewide sport fish harvest studies (1982). Alaska Department of Fish and Game. Federal Aid in Fish Restoration, Annual Performance Report, 1982-1983, Project F-9-15, 24 (SW-I-A). 119 pp.
- \_\_\_\_\_. 1984. Alaska statewide sport fish harvest studies (1983). Alaska Department of Fish and Game. Federal Aid in Fish Restoration, Annual Performance Report, 1983-1984, Project F-9-16, 25 (SW-I-A). 123 pp.
- \_\_\_\_\_. 1985. Alaska statewide sport fish harvest studies (1984). Alaska Department of Fish and Game. Federal Aid in Fish Restoration, Annual Performance Report, 1984-1985, Project F-9-17, 26 (SW-I-A). 137 pp.
- \_\_\_\_\_. 1986. Alaska statewide sport fish harvest studies (1985). Alaska Department of Fish and Game. Federal Aid in Fish Restoration, Annual Performance Report, 1985-1986, Project F-10-1, 27 (RT-2). 137 pp.
- \_\_\_\_\_. 1987. Alaska statewide sport fisheries harvest report. Alaska Department of Fish and Game, Fishery Data Series No. 2. 140 pp.
- \_\_\_\_\_. 1988. Alaska statewide sport fisheries harvest report. Alaska Department of Fish and Game, Fishery Data Series No. 52. 140 pp.
- Peckham, R. D. 1974. Evaluation of interior Alaska waters and sport fish with emphasis on stocked lakes. Alaska Department of Fish and Game. Federal Aid in Fish Restoration, Annual Performance Report, 1973-1974, Project F-9-6, 15 (G-III-E):1-34.
- \_\_\_\_\_. 1977. Evaluation of interior Alaska waters and sport fish with emphasis on stocked lakes - Delta District. Alaska Department of Fish and Game. Federal Aid in Fish Restoration, Annual Performance Report, 1976-1977, Project F-9-9, 18 (G-III-E):40-99.
- Roguski, E. A. 1967. Investigations of the Tanana River and Tangle Lake fisheries: migratory and population study. Alaska Department of Fish and Game. Federal Aid in Fish Restoration, Annual Progress Report, 1966-1967, Project F-5-R-8, 8 (16-B):247-255.

LITERATURE CITED (Continued)

- Roguski, E. A. and, S. L. Tack. 1970. Investigations of the Tanana River and Tangle Lakes grayling fisheries: migratory and population study. Alaska Department of Fish and Game. Federal Aid in Fish Restoration, Annual Report of Progress, 1969-1970, Project F-9-2, 11 (16-B):303-319.
- Roguski, E. A. and, P. C. Winslow. 1969. Investigations of the Tanana River and Tangle Lakes grayling fisheries: migratory and population study. Alaska Department of Fish and Game. Federal Aid in Fish Restoration, Annual Report of Progress, 1968-1969, Project F-9-1, 10 (16-B):19 pp.
- Schallock, E. D. 1966. Investigations of the Tanana River and Tangle Lakes fisheries: migratory and population study. Alaska Department of Fish and Game. Federal Aid in Fish Restoration, Annual Report of Progress, 1965-1966, Project F-4-R-7, 7 (16-B):231-247.
- Thompson, S. K. 1987. Sample size for estimating multinomial proportions. The American Statistician 41 (1):42-46.
- Warner, G. 1955a. Dynamics of fish populations in waters of interior Alaska. U. S. Fish and Wildlife Service, Federal Aid in Fish Restoration, Quarterly Progress Report, Project F-1-R-4, Work Plan C, Job No.3, 4 (3,4):7 pp.
- \_\_\_\_\_. 1955b. Survey of Tangle Lakes. U. S. Fish and Wildlife Service, Federal Aid in Fish Restoration, Quarterly Progress Report, Project F-1-R-4, Work Plan C, Job No. 4, 4 (1):8 pp.
- \_\_\_\_\_. 1956. Catch distribution, age and size composition of sport fish in the Fairbanks area. U. S. Fish and Wildlife Service, Federal Aid in Fish Restoration, Quarterly Progress Report, Project F-1-R-5, Work Plan A, Job No.3, 5:8 pp.
- \_\_\_\_\_. 1957. Catch distribution, age and size composition of sport fish in the Fairbanks area. U. S. Fish and Wildlife Service, Federal Aid in Fish Restoration, Quarterly Progress Report, Project F-1-R-6, Work Plan A, Job No.3, 6 (4):8 pp.
- \_\_\_\_\_. 1958. Catch distribution, age and size composition of sport fish in the Fairbanks area. U. S. Fish and Wildlife Service, Federal Aid in Fish Restoration, Quarterly Progress Report, Project F-1-R-7, Work Plan A, Job No.3, 7 (2):10 pp.
- \_\_\_\_\_. 1959. Catch distribution, age and size composition of sport fish in the Fairbanks area. U. S. Fish and Wildlife Service, Federal Aid in Fish Restoration, Quarterly Progress Report, Project F-1-R-8, Work Plan A, Job No.3c, 8 (3):7 pp.

LITERATURE CITED (Continued)

- Wojcik, F. 1953a. Reconnaissance surveys of sport fishing pressure, Fairbanks area. U. S. Fish and Wildlife Service, Federal Aid in Fish Restoration, Quarterly Progress Report. Project F-1-R-3, Work Plan 1, Job 3 (3):5 pp.
- \_\_\_\_\_. 1953b. Movements and migration habits of grayling in interior Alaska. U. S. Fish and Wildlife Service, Federal Aid in Fish Restoration, Quarterly Progress Report. Project F-1-R-3, Work Plan 5, Job 4, 3 (2):7 pp.
- \_\_\_\_\_. 1953c. Food habits of grayling in interior Alaska. U. S. Fish and Wildlife Service, Federal Aid in Fish Restoration, Quarterly Progress Report. Project F-1-R-3, Work Plan 5, Job 3 (3):5 pp.
- \_\_\_\_\_. 1953d. Survey of Tangle Lakes, Fairbanks area. U. S. Fish and Wildlife Service, Federal Aid in Fish Restoration, Quarterly Progress Report. Project F-1-R-3, Work Plan 3, Job 2, 3 (4):13 pp.
- \_\_\_\_\_. 1953e. Growth rates of grayling in interior waters. U. S. Fish and Wildlife Service, Federal Aid in Fish Restoration, Quarterly Progress Report. Project F-1-R-3, Work Plan 5, Job 1, 3 (4):10 pp.
- \_\_\_\_\_. 1953f. Biological survey of the Chatanika River. U. S. Fish and Wildlife Service, Federal Aid in Fish Restoration, Quarterly Progress Report. Project F-1-R-4, Work Plan C, Job 5, 4 (2):4 pp.
- \_\_\_\_\_. 1953g. Movements and migration habits of grayling in interior Alaska. U. S. Fish and Wildlife Service, Federal Aid in Fish Restoration, Quarterly Progress Report. Project F-1-R-4, Work Plan E, Job 2, 4 (2):1 pp.